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TRANSACTIONS
OF THE
Kansas Academy of Science.

1877 and 1878.

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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

FOR

1877-8.

VOL. VI.

TOPEKA, KANSAS:
GEO. W. MARTIN, KANSAS PUBLISHING HOUSE.
1878.

8vo.

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TRANSACTIONS OF THE

KANSAS ACADEMY OF SCIENCE.

REPORT OF THE SECRETARY.

THE TENTH ANNUAL MEETING.

The tenth annual meeting of the Kansas Academy of Science was held in Topeka, October 11th and 12th, 1877. The exercises included two evening lectures and the reading of the following papers.

1. The Internal Heat of the Globe. Prof. B. F. Mudge.
2. The Boston Natural History Society. Prof. M. V. B. Knox.
3. A New Method of Determining the Velocity of the Wind. John H. Long.
4. Notes on the Birds of Kansas. E. A. Popenoe.
5. Ozone in Kansas Atmosphere, II. Prof. W. K. Kedzie.
6. *Amblychila cylindriformis* Say. Prof. F. H. Snow.
7. Noxious Insects of Kansas in 1877. Geo. F. Gaumer.
8. River Bluffs. John D. Parker.
9. Birds of Ellis County, Kansas. Louis Watson, M. D.
10. The Iola Mineral Well. Prof. W. K. Kedzie.
11. Additions to the Catalogue of Kansas Birds. Prof. F. H. Snow.
12. Science Among the People. Dr. A. H. Thompson.
13. Illustrations of the Nebular Hypothesis. Prof. F. W. Bardwell.
14. The Occurrence of New and Remarkable Dinosaurs in the Wealden of Colorado. Prof. B. F. Mudge.
15. The "Great Spirit" Spring of Mitchell County, Kansas. Prof. W. K. Kedzie.
16. The Insects of Wallace County, Kansas. Prof. F. H. Snow.
17. Catalogue of Kansas Snakes in the State University Museum. Miss Annie E. Mozley.
18. How to Popularize Practical Science. Judge F. G. Adams.
19. The Rattlesnake. S. W. Williston.
20. Colorado *Lepidoptera*. Prof. F. H. Snow.

The lecture of the first evening was given by Prof. B. F. Mudge, on "The Value of Science," and that of the second evening by Prof. Geo. E. Patrick, on "The Chemistry of the Sun."

The officers elected for the following term of one year were:

F. H. Snow, *President.*

B. F. Mudge and J. H. Carruth, *Vice Presidents.*

E. A. Popenoe, *Secretary.*

R. J. Brown, *Treasurer.*

F. H. Snow, W. K. Kedzie, and E. A. Popenoe, *Curators.*

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THE SECOND SEMI-ANNUAL MEETING.

The second semi-annual meeting of the Academy was held in Kansas City, June 6th and 7th, 1878, in response to the invitation of the Kansas City Academy of Science.

A lecture upon "Rocky Mountain Geology," by Prof. B. F. Mudge, and one upon "Steam Navigation," by Prof. F. W. Bardwell, were delivered at the evening sessions, and the day was occupied in an examination of certain mounds in Platte county, Missouri, supposed to be of prehistoric origin. In the mounds were found remains of about twelve skeletons, and several of the skulls and some of the other portions were secured in a fair state of preservation, but the most of the bones found were so extremely fragile that they could not be preserved. The skeletons had been placed in vaults walled with stone, with an entrance toward the south. The walls gave evidence of some care in their construction, being laid very smoothly on the inside. The bones secured were placed in the cabinet of the Kansas Academy of Science.

THE ELEVENTH ANNUAL MEETING.

The eleventh annual meeting of the Academy was held in Topeka, October 8th and 9th, 1878. The first evening's lecture was given by Prof. B. F. Mudge, upon "The Rocky Mountains and their Fossils," and that of the second evening by Prof. D. H. Robinson upon "The Historical Value of Linguistic Study."

The day's session on the 9th was occupied by the reading of the following papers:

1. Connection of the Fossil Forests of the Dakota Group in Kansas with the Fossil Forests of Greenland. Prof. B. F. Mudge.
2. On a New Form of Rain Gauge. Prof. J. T. Lovewell.
3. On some Kansas Minerals. Prof. Geo. E. Patrick.
4. On Recent Additions to the List of Kansas Coleoptera. E. A. Popenoe,
5. On Recent Additions to the List of Kansas Plants. Prof. J. H. Carruth.
6. On the Dermal Covering of a Mosasauroid Reptile of the Cretaceous Formation in Western Kansas. Prof. F. H. Snow.
7. On the Bite of the Rattlesnake. Joseph Savage.
8. On the Habits of Richardson's Sphermophile. S. W. Williston, New Haven, Conn.
9. On the so-called "Alkali" of Western Kansas. Prof. Geo. E. Patrick.
10. On Additions to the Catalogue of Kansas Birds. Prof. F. H. Snow.
11. Notes on the Antiquity of Man. Dr. A. H. Thompson.
12. On Dinosauria. S. W. Williston.
13. On the Gas Wells of Kansas. Prof. B. F. Mudge.
14. On the Remains of the Mastodon in Douglas County. Joseph Savage.
15. On Science Popularized. Marcus Sayler.
16. On the Fishes of the Marais des Cygnes. Wm. Wheeler.
17. Geological Explorations for the year 1878. Prof. B. F. Mudge.
18. Botanical Notes. E. A. Popenoe.
19. On the Giant's Causeway and Fingal's Cave. Prof. C. D. Merrill.
20. On Sound Transmission by Electricity. Prof. J. T. Lovewell.
21. On the Recent Discovery of Mounds in Leavenworth County. Hon. F. G. Adams.

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22. On the Discovery of a Fine Specimen of Saurian in Colorado. H C. Towner

23. On the Adult Male Plumage of Wilson's Phalarope. S. W. Williston.

24. On the Habits of some Rarer *Cicindelæ*. S. W. Williston.

25 On the Tusk of a Mastodon found at Ottawa. Wm. Wheeler.

A committee of three, appointed to prepare resolutions of respect to the memory of Gen. John Fraser, and Prof. F. W. Bardwell, members of the Academy, deceased since the last meeting, reported the following:

Resolved, That in the deaths of Gen. John Fraser, one of our former Presidents, and Prof. F. W. Bardwell, both active members, the Academy has lost two ardent supporters, and the country, two men of talent, culture and scientific reputation.

Resolved, That we tender to the families of the departed brothers our warmest sympathies, in their great bereavement.

B. F. MUDGE, *Chairman.*
JOS. SAVAGE.
E. A. POPENOE.

The officers for the ensuing term of one year were chosen as follows:

B. F. Mudge, *President.*

J. H. Carruth, and Joseph Savage, *Vice Presidents.*

E. A. Popenoe, *Secretary.*

R. J. Brown, *Treasurer.*

F. H. Snow, B. F. Mudge, and E. A. Popenoe, *Curators.*

The following Commissioners were also appointed:

GEOLOGY.—B. F. Mudge, M. V. B. Knox.

CHEMISTRY AND MINERALOGY.—W. K. Kedzie, G. E. Patrick, R. J. Brown.

PHYSICS.—J. T. Lovewell, L. A. Thomas.

ZOOLOGY.—F. H. Snow, M. V. B. Knox, Annie E. Mozley.

ENTOMOLOGY.—F. H. Snow, E. A. Popenoe, William Osburn, Geo. F. Gaumer, T. B. Ashton.

BOTANY.—J. H. Carruth, E. A. Popenoe.

ANTHROPOLOGY.—A. H. Thompson, J. D. Parker, F. G. Adams.

PHILOLOGY.—D. H. Robinson, Geo. M. Stearns.

METEOROLOGY.—J. D. Parker, J. T. Lovewell.

ENGINEERING.—Wm. Tweeddale.

PUBLICATION COMMITTEE.—B. F. Mudge, Alfred Gray, F. H. Snow.

LOCAL ARRANGEMENT COMMITTEE.—F. G. Adams, A. H. Thompson, Mrs. N. C. McFarland, E. A. Popenoe.

THE LIBRARY AND MUSEUM.

Some small effort has been made, during the past summer, to form the nucleus of a library by exchanging the Transactions of our society for the publications of others. Although the efforts have not been extended as far as they may yet be, the publications received are of considerable value, and it is hoped that all those societies who have so far kindly exchanged will continue to do so, and that others may from time to time be added to the exchange list.

The following is a general list of the publications received:

Bulletin of the Essex Institute, Salem, Mass. Nine octavo volumes.

Transactions of the Davenport Academy of Science. Vol. 1, and Part 1, vol. 2. Octavo.

Bulletin of the Torrey Botanical Club, New York. Four octavo volumes.

Proceedings Boston Society Natural History. Vol. 19, parts 1, 2 and 3. Octavo.

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Transactions of the Wisconsin Academy of Science, Art and Belles-lettres, Madison. Vol. 3.

Proceedings of the Poughkeepsie Society of Natural Science. Vol. 1, part 1.

Archives of Science and Transactions of the Orleans Co. (Vt.) Society Natural History. Vol. 1.

Bremen Natural Science Society. Vol. 3, part 4; vol. 4, parts 2 and 3; and three quarto pamphlets on Meteorological subjects.

Royal University of Norway. Fourteen pamphlets, 1,000 octavo pages, with many plates.

Topographical Survey of the Adirondacks. One volume, octavo. From Hon. Verplanck Colvin.

Field and Forest. Three volumes, and current numbers to date.

Science Observer. One volume, and parts of current volume to date.

Psyche. Cambridge Entomological Club. Current volume to date.

Vermont Medical Journal. Vol. 1, parts 1 and 2.

Polytechnic Review. Current volume to date.

Introduction and Succession of Vertebrate Life in America, by Prof. Marsh. Pamphlet.

Of the Museum no statements need be made, except that it is poorly displayed for want of space in the Rooms of the State Board of Agriculture, and that a proper expansion and better display of the really valuable geological collection can not be made until after the building of the Capitol extension, when we hope to see it arranged in perfect order and supplemented by collections of the plants, insects and animals of Kansas.

E. A. POPENOE, *Secretary.*

NOTES ON GIANT'S CAUSEWAY AND FINGAL'S CAVE.

By Prof. C. D. MERRILL, Washburn College, Topeka.

In the month of July, in company with an appreciative companion, it was my fortune to be at the little watering place of Portrush, about the middle of the line of the northern coast of Ireland. We took a jaunting car, with a good-natured Irishman as driver, and wheeling rapidly along a very picturesque road that overhangs the sea—the seething bottom of the Devil's Punch Bowl—past rounded hills and splintered cliffs still red with the marks of ancient fire—we came, after traversing eight miles, to that remarkable object of nature, the Giant's Causeway.

This part of the Irish coast is a succession of promontories and recessions, forming vast amphitheatres in the beetling cliffs, that from a height of three hundred feet look down upon the sea. Through one of these amphitheatres we descend to the shore. On the right, vertical in the side of the cliff, stands a group of basalt columns with an exposed front forty feet high, known as the Organ. A little further on at the extreme point of the right promontory are the Chimneys—three tall groups of columns forty-five feet high, and entirely separate from the surrounding rock. On all sides of these amphitheatres, for a distance of six or seven miles along the coast, basalt columns crop out from the cliffs in irregular masses.

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Standing in this semi-circle, as we turn toward the left the Causeway proper is before us, and unlike most of the great wonders of the world, it breaks upon the view without disappointment. Here is a sharp promontory three hundred feet high, cut down abruptly at the point, nearly to the level of the sea. This promontory is composed of columns like those of the Causeway, but less perfect and more irregular in arrangement. At the base of this cliff a break in the columns is called the Giant's Gateway. This break forms the base of a triangle whose two sides meet at a distance of one hundred and twenty-five yards at the water level. These lines are the boundaries of the Causeway. As we stand on the base of the triangle then, we are twenty-five feet above the water, and have the whole Causeway before us in one view. Here are more than forty thousand columns of gray basalt standing in such close order that in most cases a knife-blade can not be inserted between them,—all so placed that the general slope from the base of the cliff to the level of the sea is as gradual and smooth as if formed for an actual highway. The length of the whole triangle is, at low tide, 125 yards.

We are told that, in all these forty thousand columns, "there is only one that is triangular—it stands in the east side of the grand Causeway. There are but three columns of nine sides, one in the honeycomb, and the other two near the triangular pillar. The total number of four and eight sides bears but a small proportion to the entire mass of pillars, of which it may be safely computed that ninety-nine out of a hundred have five, six or seven sides." Some are almost perfectly round, in others the angles of the face planes are extremely sharp and clean cut—in fact, most of the columns are beautifully defined in their sides and angles. The diameters of the pillars vary from eight to twenty-two inches—the average is about seventeen. The heads of the columns over which we walk are all either convex or concave. The concavity of a common sized column, eighteen inches in diameter, will hold nearly a pint of water—the cavities are, therefore, shallow. The tops of nearly all the columns are covered with a deposit of slime, which being often wetted by the sea, and dried by the sun, gives a dark and old appearance to the Causeway. This tendency to break in concave and convex forms proves a concretionary structure, and shows that each column is entirely separate from every other.

Dana states that the term basalt was early applied to a group of three rocks, viz: Melaphyre, Doleryte and Peridotyte, belonging to the series Hornblende and Pyroxene. Melaphyre and Peridotyte have nearly the same elements, texture and specific gravity as Doleryte, so we take the composition of the latter as that of the rock composing the Causeway. With a specific gravity of 2.75, there are as elements: Silica, 48.00; Alumina, 16.28; Protoxide of Iron, 15.55; Lime, 9.50; Magnesia, 3.85; Potash, 2.01; Soda, 2.01; Water, a fraction. A more popular analysis would be to say these pillars are composed of about one-half flinty earth, one-quarter iron, and one-quarter clay and lime. In rocks of concretionary structure like basalt, the tendency of the melted material is to concrete about centers. "Basaltic columns, then, are a result of this concretionary structure" (this grouping about centers) "and each column corresponds to a separate action. The size of the columns is determined by the consistency of the mass to be cooled; the thicker the mass, the slower the cooling and the larger the columns. The cracks separating the columns are due to contraction on cooling.

Such is the situation and the mechanical and chemical composition of the Giant's Causeway; but as we stand upon it and contemplate its wonderful formation, the mind is flooded with such questions as these: How far does it extend under the land and how far under the sea? How and when, and under what conditions, did

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it come into existence, and what is that mysterious power of nature that can thus transform the molten rock into forms of such magnitude and beauty? These and many like questions must remain but partially answered, but until they are answered, the Causeway will stand an object of the highest interest to the inquiries of the common mind, as well as to those of geological science.

Let us now transfer ourselves for a moment to the island of Staffa, off the middle of the western coast of Scotland. It is eight miles west of the great island of Mull, and about forty from the proper coast of the mainland. Staffa is a mile and a half in circumference, and the surface elevated a hundred feet above the sea, is covered with rich grass that supports thirty cattle for the tenants of the Duke of Argyle. We land from the steamer in small boats, at the eastern side of the island, the only accessible place, and walk over the surface toward the southwest corner. Here we find the highest elevation—144 feet. On the rude wooden stairs built for the purpose, we descend the cliff and reach a range of broken basalt columns, exactly similar to, and hardly less grand than the Causeway of Ireland. Along this range of columns, we proceed 150 yards to the west, and, turning a sharp angle, stand at the entrance of Fingal's Cave. Here, springing out far above us, a stupendous gothic archway supports, at a clear height of seventy feet, an entablature of crushed, prismatic basalt, thirty feet in thickness. The entire front and inner parts of the cave are composed of range on range of magnificent columns, with beautiful joints and wonderful symmetry of form. The length of the cave within is 230 feet, the roof is of solid masses of basalt, the sides of huge pillars in their usual forms, the pavement of water in ceaseless motion.

The question now arises, what connection, if any, there is between these two similar geological formations, the Causeway and the Cave. One is on the north coast of Ireland, and sloping gently under the sea, points its main ridge northward, exactly toward the Island of Staffa. The other, off the west coast of Scotland, a hundred miles away, also slopes gently under the sea, sending its main ridge southward toward the Irish Causeway. Looking at the mountain lines of Great Britain and Ireland, we find their general trend is north and south. We find also that the rocky ridge forming Argyleshire—being interrupted by only sixteen miles of shallow water between the Mull of Cantire and the Irish coast—is continued southward by the mountains of Eastern Ireland. These basalt formations, then, are found in the slopes of a great mountain valley. We find conditions similar to these in the Valleys of Connecticut, of New South Wales, and of the Hudson river, and these places are famous for their dikes, ridges of basalt columns and trap rock formations. If, then, dikes are formed under such conditions, it seems fair to connect the formation of the Cave and the Causeway as two visible portions of a vast dike, whose hidden parts are under the land and the sea. The general statement, then, will be this: At a former period a fissure was opened by subterranean force along this mountain valley, extending itself from Staffa to the Irish coast. From this fissure vast quantities of molten rock poured upward, and, on reaching the surface, crystalized into its natural forms. That there are many oblique and horizontal columns may be explained by the natural action in the dike—the top of the molten mass, crystalizing into columns first, was pushed out and over by the liquid mass rising from below. Probably the phenomena of the origin of any small dike may apply to the origin of this greater one—it may be the very magnitude of the formation that deceives the investigator of its origin.

I give here the most common of the many legends among the Irish, accounting for the formation of the Giant's Causeway: The giant, Fin McCoul, was the

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champion of Ireland, and was angry at the boasting of a certain Scotch giant, who offered to give the Irish champion a beating, provided he could cross over to Ireland without getting wet. Thereupon Fin McCoul obtained permission of the king, and built a causeway straight over to the dwelling-place of the Scot. Upon this causeway the Scot crossed over to Ireland, and was badly beaten by Fin McCoul, who then generously invited the Scot to continue in Ireland. The invitation was accepted, for everybody knows that Scotland has ever been a hard place to get a living in, while Ireland was always the richest country in the world. May not this legend point to the former existence of the whole as parts of a causeway between Staffa and Ireland? It certainly indicates an old belief of the people in the existence of such a causeway.

I conclude these notes with one more thought on the formation of Fingal's Cave —a thought that occurred to me when surveying the ecclesiastical ruins of Iona, a thought of which I can not say whether it is original because peculiar, or peculiar because original. The island of Iona, nine miles southwest of Staffa, was one of the first seats of Christianity in Britain. St. Colomba, an Irish missionary, began religious foundations there in the fourth century. He was one of the Culdees, who preferred lonely and retired places. In this island are many fine old ruins of a cathedral, a chapel and nunnery, and some peculiar carved pillars called the Iona crosses. Of these crosses there were in the island, previous to the Reformation, about 360, marking the graves of kings, abbots and monks. These crosses seemed to be of basalt, like the pillars of Fingal's Cave. Now while in Fingal's Cave, I was wondering how it was possible that the sides of the cave, as they are at present, could have been formed by the forces of nature alone. For the pillars along the sides are broken out to the width of five or six feet, leaving their broken ends adhering to the crushed basalt of the roof, while the lower ends form a pathway by which one may traverse the length of the cave as in a side gallery of a church. It seems impossible that these columns should be thus broken by nature, and so when I saw the crosses on the adjacent island, the thought came at once, that they were the missing pillars of Fingal's Cave. Is it not possible that these hardy Christians pried out, as would be comparatively easy, the pillars along the sides of the cave, and made them into the crosses that once marked the graves of their dead? The number of broken columns in the cave I judged to be about equal to the number of the crosses—three hundred and sixty. Perhaps, then, the cave as it now stands is partially the work of man.

Possibly, too, it was used as a place of retreat or worship by the Culdees before they built their cathedral in Iona. It would certainly be a beautiful thought to the Christian mind, that the earliest songs and prayers of his faith went up to the Creator from this temple of His creation, which seems to me nobler than any yet raised by human hands.

I remember that just as we were entering the cave, fifty tourists in the farther end took up together the strains of the "Old Hundredth" hymn; and as the full notes went up along the great shadowy vault, and rolling back and forth multiplied into a sounding flood of music, it seemed to me that I had never heard a hymn of praise in so appropriate a place.

Then followed the strains of "God Save the Queen," so grateful to American ears as our national hymn. And there, as it were, in the very bosom of the earth, with the prismatic tints of blue and green and gold in the vault above answering back the beams of rising light reflected from the waves below, with the boom of the sea, as it rolled its long surges up the watery aisle and hurled them thundering against the opposing wall, closed in about on every hand by the

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pillared forms of everlasting rock—what a place it was for the inculcations of loyalty to God and native land—what a place it was in which to read the story of the creation.

ON MASTODON REMAINS IN DOUGLAS COUNTY.

By J. SAVAGE.

Upon the third Friday in June, 1877, two of my neighbors, W. W. Tweed and N. P. Deming, accompanied by Prof. D. H. Robinson of the State University, spent the day upon the Wakarusa, fishing. This stream is about forty miles in length, and for the last ten or twelve miles of its course runs nearly parallel to the Kansas river, only about six miles south of it.

These three fishermen spent most the day southwest of Lawrence, upon the tract of land now owned by Judge S. O. Thacher. The day being rather warm and sultry, they sat down upon the shady banks of the stream to rest themselves. While reclining somewhat leisurely here, Mr. W. W. Tweed said to the other two that he had noticed a large bone projecting from the bank down near the water, just below where they were sitting. Whereupon, Mr. Deming arose, and going to the bone, hit it a kick and broke off a small fragment—enough to convince them that it was a real bone. This aroused their curiosity so much that they procured a spade and soon unearthed the entire bone, which proved to be the lower jaw of some very large animal. The jaw lay bottom up with the teeth downwards, and with the front end pointing into the bank, almost entirely embedded in blue clay. Prof. Robinson and others soon after wrote up the account of finding the jaw for the papers, describing it as a mastodon jaw. Its identity, however, was in dispute until the following winter, when Prof. B. F. Mudge went East and identified it as the *Mastodon Ohioticus*. This jaw has four large teeth in it, well preserved and in place, and altogether looks as though the animal to which it belonged had been dead but a few years. We are glad to state that it is now safe in the cabinet of our State University, but too frail to be transported for exhibition at our present meeting. During the fall of 1877, Prof. F. O. Marvin and the writer spent two days in exploring the banks of the Wakarusa, in order, if possible, to obtain some other portions of mastodon remains.

In this search we were unsuccessful as to finding more of the mastodon, but learned something concerning the formation of the bottom adjoining the creek, which may be interesting to relate in this connection.

The jaw was found in what was once the bottom of a fresh water lake or estuary, which extended for several miles both up and down the creek; its boundaries have not yet been determined, nor perhaps ever can be with exactness. That it extends out beneath the bottom lands adjoining, is proven by the many springs which issue from it in different localities up and down the stream, and it can be traced each way from where the jaw was found, some ten or twelve miles in extent. Beside the thick layer of muscle shells which line this ancient lake-bed, we find the trunks of old trees protruding, as well as small sandy concretions containing net-veined leaves within them. In addition to these layers of muscle shells, old trees and concretions, we also find bones of what appear to be the remains of the buffalo, antelope, elk, and some other animals as yet undetermined; but all in an unfossil-

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ized state. This goes to prove that the animals whose bones we find along the same horizon with the mastodon, and are not fossilized, did not live contemporaneously with the mastodon whose jaw was found fossilized. We conclude then, that the mastodon jaw, though not way-worn at all, was washed into this old lake-bed after fossilization had taken place, and may be all of the animal that was preserved.

I might also add, that Mr. M. Sayler, during last summer, explored the banks of the Wakarusa for some ten or twelve miles by boat; his explorations only confirmed our own previously made, and added considerably to our previous collection of unfossilized bones.

This lake-bed in which the mastodon jaw was found is about twenty-five feet below the present surface of ground. Whatever fossil treasures are in this locality we can not now determine; but so many bones have already been found that we already speak of it as the Bone-bed of the Wakarusa.

A FOSSIL TUSK, FOUND IN FRANKLIN COUNTY.

By Prof. WM. WHEELER, Ottawa.

Sometime during the spring or early summer of 1878, a farmer, living on Eight-Mile Creek, in Franklin county, observed a curious looking root or snag protruding from the bank of the creek; and upon examining it, he concluded that it must be the fossil tusk of some gigantic animal. He thereupon dug it from the bank, and took it to Ottawa, leaving it in the office of the *Ottawa Republican*. The writer of this examined the fossil at the time, but not being an expert in such matters, he did not give a decided opinion upon its character, but inclined to the opinion that it was petrified wood. A piece of the thing was sent, by the writer, to Prof. F. H. Snow, of the State University, who, after careful examination, pronounces it "*fossil ivory.*" It is, therefore, without doubt, the tusk of a gigantic mastodon.

In taking the tusk from the gravelly bank in which it was buried, two or three feet of the larger end was broken off, and the smaller end, for perhaps three feet, was not procured. The part saved measured fifty inches in length, and six inches in diameter at the larger end, three and a half inches at the smaller end. The whole tusk must, therefore, have been ten or twelve feet long.

The accompanying diagram represents the appearance of the ends when sawed square off. The appearance is very much that of the end of a small log or root, with some of the lines of growth obliterated. At these apparent lines of growth the fossil splits into layers, varying in thickness from a quarter of an inch to an inch. These layers break into short pieces, which easily crumble into irregular fragments. The appearance of the substance of the fossil is very much like that of a bone that has been boiled in lye, in the process of soap making; and the consistency is very much that of soft soap-stone. Between the layers there is a thin film of rust color, seemingly produced by oxyd of iron.

A few years ago the tooth of a mastodon was found near the mouth of the same creek, five or six miles below where this tusk was found. The rest of the skeleton is probably somewhere along the bed or banks of the creek.

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NOTES ON THE ANTIQUITY OF MAN.

By Dr. A. H. THOMPSON, Topeka.

The question of the origin and the antiquity of man has been aptly named "the great question of the nineteenth century." Its paramount importance is at once acknowledged; and as science strides forward in every other department, we can not but wonder that this, the problem of the past of our own species, a question lying so near to us, has been so long hidden from us. But it seems that the time has come in these latter years, when scientific investigation and progress in this department will no longer be kept in abeyance, but that it must be carried into parallel and symmetric advancement with other branches of natural science. The promise of this is given in the unexampled activity of investigation and the progress made in discoveries within the last score of years, and the prospect of still more rapid advancement in the near future.

Our knowledge of the antiquity of man upon the earth has been advanced slowly on account of the difficulties and stupendous obstacles against which it was compelled to labor. The greatest of these, and that which more than all else has retarded its development, has been the thralldom of Bishop Usher's chronology. For centuries every discovery tending to the elucidation of the question, was made to fit this procrustean bed, and from this slavery the science has but barely escaped. Many things have contributed to the overturning of old ideas, and the unprejudiced reception of the new. Among the latter the most prominent are the great discoveries of human remains in the formations of preceding geological epochs, until in our day the question of the antiquity of man has become an almost purely geological problem. We have advanced so much in this knowledge that the oldest historic remains become but as the tale of yesterday in the comparative age of our species. We go back thousands of years, as in Assyria and Egypt, and find a developed civilization and the capability of making written records; and then beyond that we must see other thousands of years during which that civilization was developed. Buried cities are frequently discovered of whose origin or history we have no suspicion; yet the relics of human creation there found often indicate a high cultivation and advancement in the arts of civilized life. These too, we know, point to a long period of time during which these forgotten empires were developed, flourished and decayed. But we know further that all the remains of the oldest civilizations have had their origin during the current geological epoch, and that this epoch alone is older by a hundred fold than the most ancient civilized remains extant. We pass beyond the historic period and the unknown buried cities into the period of the remains of man as a savage, so-called, the primitive age. We pass first the iron, then the bronze period, then into the stone age. In this age we pass through the neolithic into the paleolithic period—the oldest and longest of all. In the stone age we find the beginning of our own geological epoch, and that this period laps over into the quaternary—the pleistocene. In the caves and drifts of the quaternary we find man the contemporary and hunter of the reindeer, the cave bear and the mammoth, and the numerous other animals of the arctic, temperate and sub-tropical fauna, so-called, there found. But we pursue him still further and find the indications of his being in the pliocene, and the probability of finding him in the miocene. We find indeed that not only early post-glacial but inter-glacial man is a fact scarcely to be ques-

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tioned, and we see also faint rays streaming down to us from pre-glacial times, as slight indications are sighted of his pre-glacial existence.

M. Broca, in his presidential address before the French Association in 1877, gave the history of these advances in these words: "Some of the nations of antiquity boasted of great ages for their past history, * * but no actual date can be assigned for the commencement of the historic period, beyond six or seven thousand years. From history we might suppose that man is quite recent in his appearance on the globe, and much later than those geological phenomena which have modified the conditions of life, and, by the change of climates, also changed the floras and faunas. This hypothesis was accepted everywhere by geologists when Cuvier created the paleontological system, * * and who, though devoted to the idea of sudden cataclysms, understood the immense lapse of time represented by a geological period, and the comparative shortness of the historic period, and thus naturally believed that man had not appeared until long after the fossil animals. * * This idea became classical, and on all hands it was pronounced that the existence of fossil man was impossible. Many facts opposed to this opinion appeared, but they were met only with doubts and scorn. It was in vain that either in the floors of caverns or paleontological deposits, human bones mingled with those of animals of the quaternary age were discovered—systematic objections were always presented. * * Thus were cast aside the discoveries made in 1828 by Fournal of Narbonne, in the cavern of Bize; in 1829 by Christoe of Montpelier, in the caverns of the Gard—afterwards by Emilien Dunon and Dr. Pitore, in the caverns of the Gard and of the Herault; and by M. Auri Boul of Vienna, in the quaternary of lower Austria; the vast researches of Schenerling in the caverns of Liege, 1822, notably the Gluth of Elgin; the remarkable cranium of Mont Denise, found in 1844, by M. Ayward, and others. Facts of this nature in those days made no impression, however decisive they may appear to us. To overcome this opposition an overwhelming mass of evidence was required. It was necessary to prove the presence of man not only in the quaternary caverns and ossiferous periods, etc., but also in the soil of the great valleys in horizontal and undisturbed state still *in situ*. The extensive beds of sand and gravel deposited in the bottoms of existing valleys by the powerful streams of the quaternary age most often contain these conditions, and thus Boucher De Perthes, seeking the proofs for the existence of ancient man, discovered lying mingled with the bones of the rhinoceros and mammoth, the flint weapon used by man in his struggles with these monsters of another age, and the innumerable implements furnished by his hands to supply his wants. For a long time the assertions of Boucher De Perthes were not believed, his illusions were smiled at, and the dreamer was pitied. But from 1840 to 1858 he struggled against indifference and disbelief, only asking for the examination which was denied him, until in the latter year, when Falconer from England went to Abbeville to see and examine the sites explored and the rich collection of worked flints and fossil bones there found. Other English *savants*—Prestwich, Evans, Gilmore and Lyell—followed, and themselves made successful searches at different points in the valley of the Somme for implements. French *savants* in their turn arrived, and M. M. Gaudry, Pouchet and others, obtained with their own hands axes of worked flint from the quaternary deposits of the Somme. Perthes' facts were thus fully confirmed. Discussion was given them at the Society of Anthropology of Paris, the question was examined in all its aspects, and all hesitation removed. Fossil man had henceforth an established place in positive science. * * To the names already mentioned, history will add those of Eberhardt of Wurtemburg, of Esper, of John Frere, who in the eighteenth century, before the

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classification of geological epochs, dug up human remains and worked flints, now recognized as belonging to the quaternary. Justice will be done to Jages, who in 1825 recognized the great antiquity of the Constadt skull, which was discovered upwards of a century earlier, and was for a long time considered apocryphal; but with due praise to those early workers, it is Boucher De Perthes who will receive the homage due the bold wrestler who maintained the final struggle and came off the victor.

"The year 1859 beheld the theory of the antiquity of man burst upon the scientific world with irresistible force. * * All Europe, geologists, anthropologists, archeologists, threw themselves into the work with startling energy. Only eighteen years have now elapsed, and never, perhaps, in so short a time has such a rich harvest been gathered. Who can forget those days of his life when, from the bowels of the earth, from the depth of caverns, sounded the voice of the past, and the fossil communities lived again. * * Boucher De Perthes had only lifted a corner of that mysterious veil which hides the origin of man, and had proved that man had existed throughout the quaternary epochs, that he had been in France the contemporary of the reindeer, and animals which now only exist elsewhere, and of the mammoth and other extinct animals. But was this all? And was not the human race yet more ancient? This last question presents itself at once, and even more important than the other, for each of the three periods of the tertiary age was of much greater duration than the quaternary. The researches concerning tertiary man include the discoveries of M. Desnoyers, near Chartres, and of Prof. Capellini, in many tertiary sites in Tuscany, which tend to establish the fact of the existence of man in the pliocene age; those of Abbe Bourgeois of Thenay, would carry back even to the miocene age—that is, to the middle tertiary—the existence of an intelligent being who could work flints, and could only be man. * * But tertiary man is yet only on the threshold of revival, and the evidence in his support requires more definite proof. * * Quaternary man, on the other hand, has now become classical. He has been found in most parts of Europe, and in many places in the New World. His weapons and implements have been found and preserved by hundreds of thousands. * * There are got materials from the earth of valleys in which the relative position of the strata is enough to mark their date; at others from deposits rich in natural flints, where quaternary man had established his workshops; here, in the rock shelter where he camped; there, in the caves in which he lived. In the cave dwelling places the finds have been most abundant, and we have been able to study even the details of the life of a tribe, the remains of repasts, the weapons for the chase and for fishing, the sewing implements, all the products of the flint worker, to which may be added at a certain period, handsome implements of bone and reindeer horn; then, the symbols of power, ornaments, objects of commerce, the works of artists, sometimes rude and uncivilized, at other times full of grace, motion and truth, represented by engraving or sculpture, the animals hunted in those days—the bull, horse, aurochs, reindeer, the great cave bear, and the gigantic mammoth. Quaternary man has his chronology, not one of years or periods, like ours, but of archeological and paleontological periods, vast spaces of time, taking date according to the various fossil species which predominated unceasing around him, and according to the different types of implements marking the gradual evolution of his work. He has his history also, not indeed political, but anthropological; not that of peoples and chiefs who became celebrated, but that of races who supplanted and succeeded one another on the same soil."

So much for quaternary man, but what of a still older than he? We have seen that intimations have been discovered of tertiary man—that pliocene man is a prob-

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ability and miocene man a possibility. In pursuing the subject further, we observe that on May 22, 1877, a conference of the Anthropological Institute of Great Britain was held upon the subject of the present state of the question of the antiquity of man in England. Mr. John Evans, F. R. S., the president, in his opening remarks, said, "the question laid equally in the domain of, first, the archeologist (who should decide upon the genuineness of articles of human workmanship); 2nd, the anthropologist (who should decide upon human bones), and 3rd, the geologist (who should decide upon the geological age of the deposits), and that great care and caution should be received as to the acceptance of evidence, and that sources of error should be carefully watched for and eliminated." He then alluded to the discoveries, "first, of that at Thenay, of implements which are attributed to a miocene age; to that of the bones of the whale, near Sienna, which are regarded as having been cut by man. There is doubt as to whether this is pliocene or later: of a human skull in a bed regarded as pliocene. There is doubt as to this—especially as a neolithic-appearing spear-head was found in company with it; to that near Lake Zurich of cut staves of wood and other staves with shavings around them in the inter-glacial lignite; and to others. In these discoveries, the whole question turns upon the geological age of the deposits. There is but little doubt that if the quaternary man of Britain had attained the ability to fabricate what he has left, and to subsist in such a climate—for these people may have been colonists or wanderers from the original stock whose home was under a more favored clime—that remains of yet earlier members of the human race will eventually be found."

A paper was read by Prof. Boyd Dawkins upon the "Evidence of the Pleistocene Caves of Great Britain," in which he said that "it has been recently urged that all paleolithic deposits both in caves and river beds are of pre- and inter-glacial age; that is, that they date back to an antiquity vastly more remote than that post-glacial period to which they have been referred by Lyell, Prestwich, Evans and others. The argument is based on those conditions of life which are said to be inconsistent with those of post-glacial times. * * * The antiquity of man can not be measured by the chronology of the historian, but by the sequence of those physical and biological changes which are so familiar to the geologist. * * * The nature of the evidence of the caves may be best estimated by taking a particular case; say that of the paleolithic caves of Cresswell Crags. * * * On the floor of these caves was, first, a layer of light-colored sand without fossils (the result of the decomposition of the rock below), next, the lower ossiferous strata, consisting of red sand and clay, averaging three feet in thickness and containing numerous stones and fragments of fossil bones and teeth. These latter are all scored and marked by teeth—the prey of hyenas, and dragged into these dens piecemeal, and well scattered through the sand and clay as the result of the occasional flooding of the caves by the stream, which was then near the entrance, although twenty feet below at the present time. These bones belong to the lion, spotted hyena, reindeer, Irish elk, bison, rhinoceros, mammoth, and some other animals. To these must be added man, who left a few rounded quartzite pebbles and flakes of quartzite, of the rudest and roughest sort. The whole group of caves points out that savages of a low order visited the district from time to time. Above the red sand was a fine red loam, sometimes in the upper part or limestone breccia. In this were fragments of bone, some gnawed by hyenas, others broken and scratched by man and associated with charcoal and burnt bone, and implements of quartzite flint and ironstone, of types well known in England and Europe. Implements of flint and bone were very numerous of various kinds, and the incised figure of a

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horse, well drawn, on a rounded and polished fragment of rib. The species of animals represented were more numerous than in the lower bed. Above this bed was a layer of stalagmite ranging from one foot to a few inches in thickness. The human occupation of these caves consisted of three distinct periods: first, the rough quartzite period; then the quartzite and flint; then the flint and bone—the period of the artistic drawing and the elaborately worked implements. These three stages indicate a distinct progress in art among the cave-dwellers. * * * The mixed fauna universally found in British caves, can be explained better on the principle of seasonal migrations, than glacial aeons." * * He concludes also, "that paleolithic man belongs to the northern group of animals, being associated most frequently with the reindeer and the northern fauna—that of the late pleistocene. And also that some of the northern caves may have been older than post-glacial, which shielded the paleolithic hunter." He then concludes, "that according to the evidence of the associated mammalia, man was probably in Europe while the ice covered large tracts in England, North Germany and Scandinavia, or in pre-glacial and inter-glacial times, and he was an inhabitant of the Denbigshire caves after the ice of the second ice period had passed away from that region."

Prof. T. M. Hughes spoke of the "Evidences afforded by the Gravels and Brick-earth of the East Anglican district, in which remains of man before the close of the glacial period have recently been found. These deposits are post-tertiary boulder clays and gravels, and he concludes that man appeared upon the scene early in the post-glacial period." Mr. R. H. Tiddeman spoke of the "Age of the Hyena-bed, Victoria Cave, Settle, and its relation to the question of the antiquity of man"—in regard to the very remarkable human fibula found therein, concerning which there was so much discussion. Animal bones cut with human implements were also found in this bed. In summing up he says: "Even supposing that we had never found traces of man in Victoria Cave in the older pre-glacial beds, his great antiquity would be there fairly proved. A set of animals known to exist with man elsewhere, is there shown to have lived before an age of great land glaciation. That ancient fauna lived in the south of England and the eastern counties upon a land surface covered with the vestiges of a still older and more extensive glaciation, the traces of which have been swept away in the north by that later glaciation. This glacial period, which I consider to have been later than man's introduction into Europe, appears to be the same which spread over the whole of Scotland and perhaps of Ireland, with a sheet or sheets of land ice." In the discussions which followed, Prof. Prestwich said: "Evidence on this subject is afforded by the boulder clay which reaches as far north as London. That represents the glacial period." The post-glacial he considers "to be subsequent to the period of the deposit of the boulder clay. * * It is in the drift and gravel of the valleys excavated *in* this boulder clay that paleolithic implements have been so commonly found; consequently, it is clear that in that area man is of post-glacial age. * * In the south of England there is evidence that both areas of the land were inhabited by animals likely to serve as the food of man, previous to the boulder-clay period, and that man probably existed before that period in the north of England. * * He believes, with Mr. Tiddeman, that the evidence of Victoria Cave rather tends to show that it is pre-glacial. * * He considers that the data for carrying man back to the boulder-clay period, is an account audited and passed, and he has good reason to believe, from his own observations, that man was pre-glacial in the north of France."

Prof. Virchow, of Berlin, delivered an address before the German Association of 1877, in which he says of this question: "At this moment Anthropology

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studies the question of fossil man. From man in the present 'period of creation' we have descended to the quaternary period, where, as Cuvier maintained with the greatest confidence, man never existed at all. Nowadays, quaternary man is a generally accepted fact; is no longer a problem, but a real doctrine. But tertiary man is a problem — of course a problem which is already in a stage of material discussion. There are objects already about which discussions are going on as to whether they may be admitted as proofs for the existence of man in the tertiary period. * * Even men who, like Abbe Bourgeois, are decided ecclesiastics, are convinced that man has lived during the tertiary period; for them tertiary man is already a doctrine. For us, who are of a more critical nature, tertiary man is a problem, but, as we must acknowledge, a problem worthy of discussion. Let us, therefore, for the present, remain at quaternary man, whom we really do find. * * It may indeed be that tertiary man has existed in Greenland or Demaria, and will again be brought to light from under the ground somewhere or other."

At the last meeting of the British Association, Dublin, August, 1878, Prof. John Evans, in his address before the Geological section, said: "One of the questions which has of late occupied geologists, is the age to be assigned to the implement-bearing beds of the paleolithic age in England. Dr. James Geikie has said that for the most part they belong to an inter-glacial episode towards the close of the glacial period, and regards it as certain that no paleolithic bed can be shown to belong to a more recent date than the mild area that preceded the last great submergence. His follower, Mr. Skertchly, records the finding of paleolithic implements in no less than three inter-glacial beds, each underlying boulder clays of different ages and somewhat different characters—the Hessle, the purple, and the chalky boulder clay. * * I have always maintained the probability of evidence being found of the existence of man at an earlier period than that of the post-glacial or quaternary river gravels. * * In the present state of our knowledge, I do not feel confident that the evidence has arrived at a satisfactory stage of certainty." Before the Biological section, Prof. Huxley delivered a short address, in which he referred to the question of the antiquity of man as follows: "Great progress has been made in the last ten years in the direction of the discovery of man in a fossil state. My memory goes back to the time when anybody who broached the notion of the existence of fossil man would have been laughed at. It was held to be a canon of paleontology, that man could not exist in a fossil state. * * But it is now beyond all question that man—an intelligent man—existed at times when the whole physical conformation of the country was totally different from that which characterizes it now. Whether the evidence we now possess justifies us in going back further, or not—that we can get back as far as the epoch of the drift is, I think, beyond any rational question or doubt; that may be regarded as something settled—but when it comes to a question as to the evidence of tracing back man further than that—and recollect, the drift is only the scum of the earth's surface—I must confess that to my mind the evidence is of a very dubious character."

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OZONE IN KANSAS ATMOSPHERE.

By Prof. W. K. KEDZIE.

At the eighth annual meeting of this Academy, I had the pleasure of presenting a preliminary paper upon the occurrence of ozone in the atmosphere of Kansas. At the time of the presentation of that first paper, observations upon the subject had extended over a few months only; but even for this short period the results obtained were very striking, and compared very favorably with similar series of observations in Eastern States, both as to the constancy and amount of this important element of *pure air*. The results now submitted are those obtained from much more extended observation, for two years past, at various stations through the State.

The vital facts of the nature of ozone, as given at length in that first paper, may be briefly summed up as follows: 1st. That ozone was discovered by Schonbein, of Basle, in 1840, and that it is a condensed allotropic form of oxygen, having the formula O_3, and the equivalent 48. 2d. That it is produced in our atmosphere:—*A*, By electricity, both by lightning and by silent discharges; *B*, By all processes of oxidation, whether by rapid combustion or slow decay; *C*, By the evaporation of large bodies of water; *D*, By the process of vegetable growth, in which carbonic acid is decomposed in the leaf cells of the plants, the carbon retained and the oxygen thrown out again, always commingled with a trace of ozone. 3d. It was also shown that as rapidly as the ozone is produced in our atmosphere it is consumed again in the oxidation of all decaying animal and vegetable matter; by which means the air around us is maintained pure and free from all the offensive and poisonous products of decay. Hence, that around large cities, where decaying organic matter is constantly accumulating, ozone is only found in minute traces, while in the free air of the country it frequently exists in very appreciable quantities. It is also more abundant in winter than in summer, as during cold weather all process of decay and oxidation, by which ozone is consumed, are at a standstill. Generally, too, ozone is more abundant during the night than through the day, though this rule is by no means invariable, and during warm weather the condition is reversed altogether. 4th. It was finally shown from comparative records embracing the months from January to August, 1875, that the indications of ozone are much more abundant and strongly marked in the atmosphere of Kansas than in that of many of the States further east.

Since the presentation of this first paper, no further investigations have thrown any new light upon the general nature of ozone, except some exceedingly interesting results recently obtained by M. Berthelot, and presented by him in an article in the February number of the "Annales de Chimie et de Physique," for the present year. M. Berthelot has, by a number of very beautiful experiments, here shown that whenever ozone is formed by the action of the electric current upon oxygen, heat is absorbed; which heat is given out again when the ozone expends itself in the process of oxidation of other bodies. This fact, it is claimed by Berthelot, explains its superior activity to that of ordinary oxygen.

For the purpose of more fully investigating the occurrence of ozone in the atmosphere of Kansas, it was proposed that to any member of this Academy who would lend his assistance in conducting carefully recorded observations there would be furnished gratis, blanks, test paper and color scales. This offer met with a most generous

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response, not only from members of this society, but from many other interested observers in distant parts of the United States. I have been under special obligation, the past year, to the kind assistance of the following gentlemen: Mr. B. B. Smyth, of Ellinwood, Barton county; Prof. John B. Dunbar, of Washburn College; Dr. A. H. Thompson, of Topeka; Messrs. J. H. Long and W. H. Carruth, of Lawrence; and L'Abbe Victor A. Huart, of the Seminary of Chicoutimi, Canada. Correspondence has also been opened with other observers too numerous to be enumerated here. The State Medical Society of Kansas was also, at the outset, quite disposed to lend its assistance in prosecuting this investigation, until some of its officers conceived the erroneous idea that the matter had already been made the subject of a report by the American Medical Association, and, of course, to further discuss any problem upon which so august a body had already passed, was quite out of the question! That such an impression was entirely unfounded is evident from the following letter:

PHILADELPHIA, October 6, 1876.

PROF. WM. K. KEDZIE,

DEAR SIR: The only consideration of Ozone is an attempt to have its amount in the atmosphere noted and published by the Signal Service Bureau. This was a resolution attached to a report in 1875, by Dr. N. S. Davis, of Chicago.

Truly yours,

WM. B. ATKINSON,
Permanent Secretary American Medical Association.

The doctors of the State need therefore have had no fear that in giving this matter attention, they would have been guilty of rehearsing an old subject. The test adopted in our observations, has been that known as the "Iodized Starch Paper" test, devised by Schonbein. Ten parts of starch are boiled in 200 parts of distilled water, to which, when cold, one part of potassium iodide is added. This is applied with a fine water brush to strips of unsized paper, which must be dried and preserved in the dark. When small strips of this paper are exposed to the atmosphere, if ozone be present, it will at once decompose the potassium iodide, setting free the iodine, which in turn combines with the starch, forming an intensely blue compound, at once apparent upon plunging the paper into water. The degree to which the paper is colored thus affords a very fair evidence of the quantity of ozone present in the atmosphere at that time; and may be recorded by comparing it with the color scale,—a scale of color bands upon paper, numbered from one to ten, and varying from the faintest to the deepest blue. The number of the color band to which the paper most nearly corresponds, is then entered in the record as the result of that observation. It is important that the test paper should be exposed to the air in a sheltered situation, protected both from strong wind and from direct sunlight, though freely exposed to the air and to diffused daylight. This color test of Schonbein is very far from being perfectly satisfactory in its operation or results. It is arbitrary, and indicates only the relative quantity of ozone present in the atmosphere; but it possesses the great advantages of being simple and easily comprehended, and is undoubtedly by far the best for use among general observers. Two series of observations have been conducted: First, the "Day observation," in which the paper is exposed from seven A. M. to two P. M. Second, the "Night observation," embracing an exposure from nine P. M. to seven A. M. The results of these observations have been recorded on blanks printed for the purpose, which have been regularly forwarded to me at the close of each month, the results being carefully tabulated. I have been under many obligations to Dr. H. B. Baker, Secretary of the Michigan State Board of Health, for the loan of similar records of

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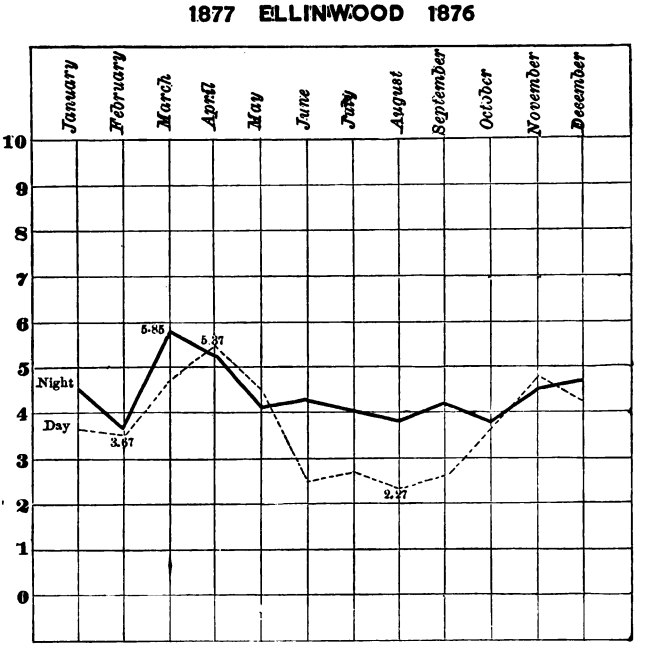
observations taken at typical stations in that State. A comparison of these records results, as already stated, very favorably to the atmosphere of Kansas, both in the amount of ozone present, but especially in the high averages of the spring and summer months. These changes in the quantity of atmospheric ozone, during the different seasons of the year, nowhere appear so strikingly as when presented in diagrams. For the purpose of exhibiting these changes, I have constructed a diagram for four of the Kansas stations, in which, by a broken dotted line for the "Day observations," and a dark line for the "Night observations," the variations in amount of ozone in our atmosphere are vividly shown for each month throughout the year.

These diagrams show finely the general characteristics of ozone records, viz: the superiority of the night observations over those for the day, except during the warm summer months, when the condition is usually reversed; and the gradual fall of the quantities registered, from a high mean during the winter months to a comparatively low condition during summer, followed by a rise again with the approach of the succeeding winter. But the important feature already mentioned in the relatively large quantity of ozone indicated by some of our stations during the spring and summer months, is shown with especial prominence on comparing these diagrams with the records of Eastern stations. Each of these diagrams will well repay individual attention and study. The observations at Lawrence under the charge of Mr. Long, are chiefly remarkable for the fact that the night records maintain their superiority over those of the day only to the month of May, when they at once drop below the day results, and remain below them throughout the year, with the exception of a slight rise during the latter part of July and the first of August. The night records attain their highest mean, 4.77, during March, and their lowest,



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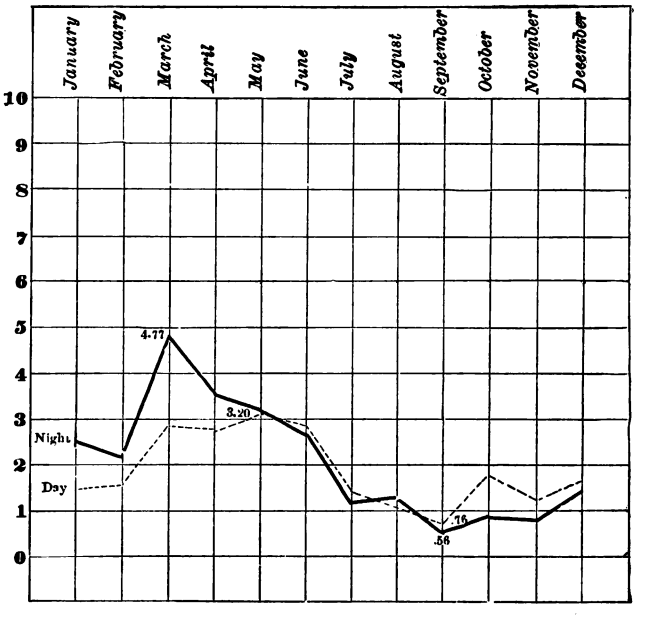

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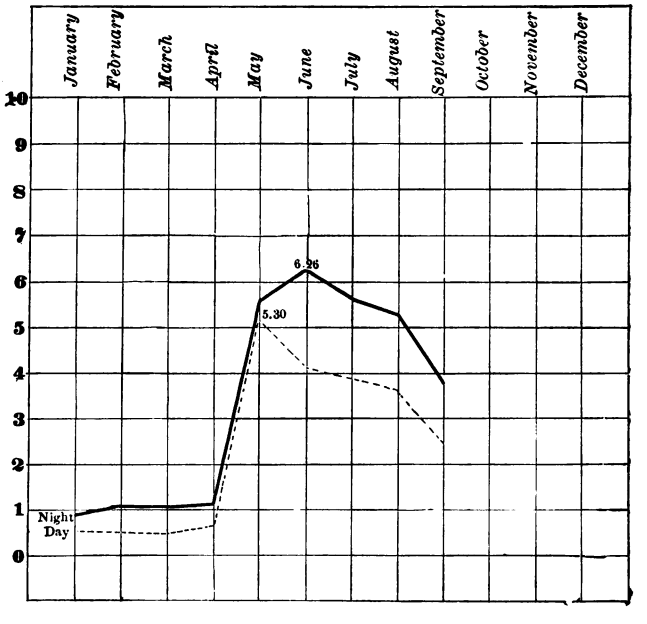

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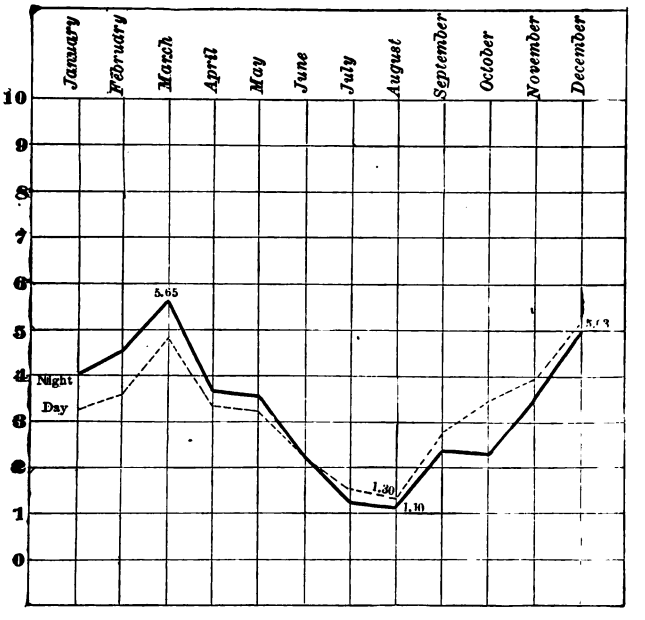
1876 MANHATTAN 1876



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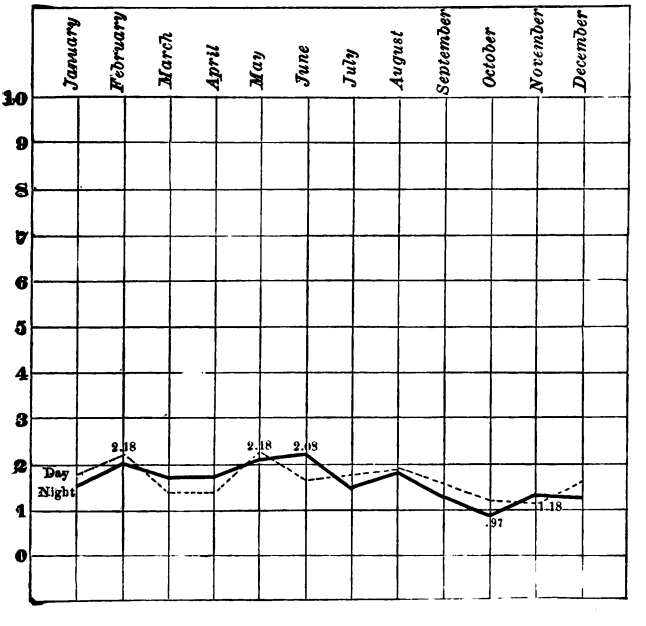

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.56, in September. The day records present their highest mean, 3.20, in May, and their lowest, .76, in September. These minimum results are the lowest obtained in the State. Mr. Long has prepared his own iodized paper, and his observations have been conducted in the city of Lawrence, near the foot of University Hill, upon a street largely populated by colored people. These records are now under charge of Mr. W. H. Carruth, who has transferred his base of observation to a much higher locality, nearly upon the same level with the University, where he has obtained quite startling results. For the month of May, for example, he has obtained a maximum of 10 (highest on the scale) for both day and night records, with a mean for the month of 5.30 for the day and 5.55 for the night. The records of the station at Ellinwood have been conducted by Mr. B. B. Smyth, beginning with June, 1876. They are characterized throughout by a uniformly high average. The night records almost invariably far exceed those of the day. The highest mean of the night records is reached in March, 1877, 5.85; the lowest in February, 1877, 3.65. The day records attain their highest mean in April, 1877, 5.37; their lowest in August, 1876, 2.27. These results would seem to indicate a greater quantity of ozone in the higher regions of Western Kansas than in that of its lower eastern border. The observations at Washburn College, Topeka, have been under the charge of Prof. John B. Dunbar. They were begun in April, 1876, and are chiefly remarkable for their great uniformity throughout the year, and for the alternate superiority of the day and night records. I have never in my experience seen records varying so little in their results. The highest mean for the night is in June, 1876, 2.08; the lowest in October, 1876, .97. For the day records the highest mean is reached in May, 1876, and February, 1877, 2.18; the lowest in November, 1876, 1.18. Among the most interesting results obtained were those by Dr. A. H. Thompson, of the city of Topeka. Dr. Thompson's place of observation was adjacent to the A., T. & S. F. Railway depot, with the bulk of the city lying south and west and north. The prevailing winds of this locality thus brought foul air from almost every direction, and, as a natural result, scarcely a trace of ozone could be detected. This result was due both to the presence of organic impurities with which the atmosphere was loaded, and also to the sulphurous acids in the coal smoke of the railway which would instantly destroy whatever color might have been imparted to the test paper. This powerful bleaching effect of sulphurous acid may be easily shown experimentally by holding a test paper, turned a deep blue by the action of ozone, near a freshly lighted sulphur match, when the color will instantly vanish. Observations taken in other portions of the city by both Dr. Thompson and Prof. Thomas, furnish somewhat higher results. The records of Manhattan under my own supervision show for the past year somewhat lower results than those obtained in 1874-5. Upon examining the diagram the somewhat singular fact is noticed, that from January to June the night records exceed the day; and from June to December the day records exceed the night in about equal amounts in each case. The highest mean for the night observations is reached in March, 5.65; the lowest in August, 1.10. For the day records the highest mean appears in December, 5.03; the lowest in August, 1.30. It was the intention in organizing these series of observations, to study and record with great care all phenomena in connection with ozone which might in any manner assist us in ascertaining its relations, if any exist, to health and disease. Observers were requested to specially notice and record "any apparent connection between the abundance or deficiency of ozone, and the prevalence or absence of any given diseases; or any influence observed in modifying the types of such diseases." But it is quite needless to state that the failure of promised co-operation has prevented any investiga-

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tion of this very interesting question, which eminent medical authorities in Eastern States have considered well worth their attention and study. Until an abundance of such data shall accumulate, any attempt at discussion of the relations of ozone to health and disease, will prove, from necessity, fruitless and unsatisfactory. There are not wanting, to be sure, persons whose opinions upon this question are very positive and very emphatically expressed—as those of the superficially minded usually are. Such may be readily classified under two heads. First, those who look upon ozone as nature's great specific—the universal cure for all ills to which frail human flesh is heir. Second, those, who after a slight and trivial examination of the subject, have failed to arrive at any conclusions satisfactory to themselves, and hence ridicule the suspected relations of ozone to health and disease, as visionary hallucinations. The testimony of both these classes of "thinkers," is of about equal worth. The arguments of both smack strongly of "personal conviction;" their conclusions are wholly without any foundation in fact, and hence are utterly and completely valueless. What is wanted to-day, above all things else, is calm, unprejudiced, unimpassioned observation and study of accumulated facts. Our present knowledge of the relations of ozone to the laws of health, is, at best, of very general nature only. We know that while ozone is a constant and normal ingredient of pure air, that the amount present at any one time is always very minute—never over one part in 450,000 by weight. On the other hand, ozone can not exist in foul air, laden with organic effluvia, and there are many observations which have shown either its entire absence or presence in very minute quantity during the prevalence of certain types of epidemics, though its relations to zymotic diseases is by no means yet clearly established. Ozone is also a most vigorous disinfectant; and one of the most simple and beautiful methods recommended of purifying the air of a sick room, is by use of the well-known flameless or "aphlogistic" lamp, which in its slow combustion, continuously generates a small supply of ozone. This lamp is easily constructed, by placing a small piece of platinum sponge, or a small coil of fine platinum wire even, upon the wick of a common alcohol lamp, partially surrounding it with the fibers of the wick; lighting the lamp and then cautiously blowing it out, when the metallic mass will continue glowing at a red heat for several hours from the slow combustion of the alcohol, in which process a minute quantity of ozone is liberated. On the other hand, it is well known that air containing an excess of ozone can not be respired, and is fatal to animal life. When present in much greater than average quantity in our atmosphere, ozone almost invariably produces violent bronchial and catarrhal troubles among persons susceptible to these difficulties. This coincidence I have noticed repeatedly in this State. In an exceedingly interesting address delivered in 1875, by the President of the State Medical Society of Michigan, some very interesting experiments are given, tending to prove that sunlight itself, acting on organic matter in the presence of free oxygen, is a powerful generator of ozone. Slips of iodized paper were exposed to bright sunlight in jars of carbonic acid, hydrogen and nitrogen gases for days, without undergoing the slightest coloration. The same result was obtained when a slip was exposed in the same manner between tightly sealed plates of glass. But when the glass was cracked, to allow the access of atmospheric oxygen in the presence of sunlight, the paper slip became perceptibly colored in a few hours. Thus is suggested a very interesting explanation of the well-known importance of the access of an abundance of bright sunshine, for pure air and good health within our homes. All these fragmentary facts show what a fascinating field for study and investigation lies within our easy reach; and when we add to all this the peculiar import-

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ance which attaches to this subject in our own State, our attention is awakened with redoubled interest. These carefully recorded observations in progress for the two years past, have established beyond a doubt, the existence of a liberal quantity of ozone in Kansas atmosphere. The universally healthful character of the climate of the State, is so widely known a fact as to need no comment here. And in addition to our almost absolute freedom from epidemic diseases of every character, our State is just now attracting very general attention as a desirable resort for consumptive patients. Sufferers unable to endure the rare atmosphere of the higher regions of Colorado, now frequently find returning health by a protracted residence in Kansas. Has the ozone of our atmosphere any connection with this fact? is an inquiry not infrequently addressed me by interested physicians from the East—to whom a satisfactory answer can be given only after long study and extended observation. In view of all the interesting features of this attractive theme, I can conceive of no more promising a subject of study than this of the offices of the ozone of our atmosphere in health and disease. Such an investigation may not, to be sure, either lighten our taxes or increase the value of our farm products. But it will be the means of revealing to us more fully an accurate knowledge of the wonderful resources with which nature has endowed us as a State; upon which, after all, rests the foundation stone of our material prosperity.

ON SOUND TRANSMISSION BY ELECTRICITY.

By Prof. J. T. LOVEWELL, Washburn College, Topeka.

Two years ago a Boston teacher of vocal culture astonished the world by exhibiting at Philadelphia an instrument by which a person, talking, singing or making any sound at one extremity of an electric circuit, might have the same words and tones faithfully reproduced at the other extremity.

At that time few people knew that this subtle agent, electricity, could be employed in the transmission of sound, though this thing had been done many years previously.

In 1837, Prof. Chas. Grafton Page, for many years an Examiner in the Patent Office, utilizing Prof. Henry's discoveries, succeeded in producing what he termed "galvanic music." This phenomenon at once attracted the attention of scientific men, and, among others, the French electrician, De la Rive, investigated the subject with great care in 1843. Nothing came of these researches, except to add another laboratory experiment illustrating the physical principles of electricity.

In all these cases the sound transmitted was first produced by the vibrating spring of an induction coil which opened and closed an electric circuit; and the same tone was reproduced by an electro-magnet through which the interrupted current passed, and whose vibrations corresponded with those of the spring of the induction coil.

There was, following this, more or less crude speculation on the possibilities of transmission of sound by electricity, but nothing better than De la Rive's experiments is recorded till 1861. At that time Philip Reiss, teacher of a school at Friedrichsdorf, near Homberg, entered the field of investigation with the true German spirit. His first telephone was made with a beer barrel, the bung of which

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was pierced with a conical hole, and over the smaller end the skin of a German sausage was stretched. Another tubular opening into the barrel allowed this membrane to be put into vibration by tones of the voice. These vibrations, by suitable mechanism, opened and closed an electric circuit, and the interrupted current passed through an electro-magnet properly mounted on a box for strengthening the sound.

The German pedagogue still flourishes, and has made many improvements in his original telephone—some of quite recent date.

A writer in the *Polytechnisches Notizblatt*, in 1863, says, that not only tones, but words, could be communicated by Reiss' telephone, if such as heard frequently; and in 1865, Yeates, an instrument maker of Dublin, introduced a modification of Reiss' instruments that was said to transmit words well, by members of the Dublin Philosophical Society. Reiss named his invention a telephone, a name that had then been in use many years, and was applicable to all instruments for transmitting sound to a distance. Reiss suggested that this kind of sound transmission might be the basis of improvements in telegraphy, but no practical applications were made, and telephones were merely philosophical toys until Bell's work culminated in 1876.

Till that date our best text books, if allusion was made to it at all, dispatched the subject of electrical transmission of sounds in a paragraph. Since then, the progress of the science has been simply wonderful, for we may surely call telephony a science bringing forth several volumes in two years, and being the subject of articles innumerable in all classes of journals, and the topic of inquiry and curiosity everywhere. I have no time to pursue my theme historically, any further, nor do I wish to enter on the disputed question of priority.

A discussion of principles and applications is more worthy the attention of the Academy.

We may divide electric telephones into three classes: 1st. Those already described, where the vibrations of a reed, or membrane, cause interruptions of an electric circuit, thus sending intermittent currents to a distant station. These currents have the same frequency as the pulsations of the sound-wave that caused the interruptions, and will produce in the electro-magnet pulsations of like frequency. We thus get a tone of the same pitch as the original note which is sung by the voice or emitted by the vibrating reed. The quality of the tone—its timbre, will depend on the kind of mounting given to the electro-magnet. The most elaborate telephone of this class, yet constructed, is that made by Prof. Gray, of Chicago. For the original tones he used reeds of different pitch, vibrated by electric influence which was controlled by keys like those of a piano. At the receiving end he had an ingenious and complicated apparatus for reinforcing the sound. It was Prof. Gray who gained such wide celebrity by his telephonic concerts, in the first of which, music in Chicago was reproduced in Milwaukee, greatly to the surprise and delight of a large audience.

Prof. Gray, as electrician to a telegraph company, naturally sought to utilize the principles of his musical telephone in multiplex telegraphy, and has been measurably successful, though the time does not seem ripe yet for its universal adoption. Aside from its novelty, the music from this sort of telephone has no special charm. It is apt to sound weird and doleful, and reminds one of hand organs, such as are ground by old beggar-women, to attract notice and sympathy, sitting with their starved children beside a gutter. As a musical instrument it is not a success, as Artemus would have said.

Telephones of the second class, of which Bell's instruments were the precursors

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and type, soon gained popular attention, not only by their interest but by their practical applications also. Bell's researches were begun and carried forward in the true spirit of the philosopher, and though the goal reached was not at first aimed at, he exhibited true genius in seizing the clue offered, and following it out so faithfully. Following in the footsteps of a father somewhat famous as the author of "Visible Speech," Bell was seeking some way to make the sound-wave give a permanent, visible and legible record of itself. He found the manometric capsule of Konig, and the phomantograph of Leon Scott, unsuited to his purpose, and sought to improve the latter by making it after the model of the human ear. A friend suggested the use of the ear itself, and the success of their experiments with this novel apparatus gave the clue that Bell needed. If, thought he, a membrane like the tympanum of the ear can move a series of bones, relatively of large size, why will not a larger membrane move a magnet that will vary the intensity of the electric current in waves corresponding to the sound waves? He had before sought in vain to reach a similar result by the means of sympathetic vibrations, but his new effort with the vibrating plate was crowned with triumphant success.

I have indulged in this sketch of the genesis of the vibrating plate since it is to be regarded as the fundamental idea of the second class of telephones, and one of the most suggestive and fruitful discoveries of the age. Three forms of instruments were exhibited at the Centennial, Philadelphia. The principle in each was the same, and in construction there was a battery sending a continuous current between the receiving and sending stations. At each of these places it passed through coils of fine insulated wire, having as a core a piece of soft iron. This of course became a magnet, and directly in front of it, distant say one-thirty-second of an inch, was fixed a thin plate of iron. A suitable mouth piece before the plate converged the sound upon it and gave the vibrations. It must be remembered that the iron plate is in the magnetic field and has become a magnet. Its vibration, therefore, according to well-known electrical principles, caused electric pulsations to pass through the coil of wire, the intensity and direction of the currents being proportional to the velocity and direction of the moving plate. A vibrating plate, according to well-known acoustic laws, has property of dividing into nodes and ventres so that it can harmonize with any sound-wave, however complex. Thus it results that the plate copies the sound-wave and the electric pulsations copy the plate. Now these pulsations passing through the helix at the receiving station, change the magnetic state of its iron core, and consequently the attractive force of the latter on the plate in front, just in proportion to the frequency, intensity and direction of those pulsations. A vibration thereupon ensues which copies in all its minute detail the original vibration of the first plate and sound-wave. This is transmitted to the air and thence to the ear. Thus we have a sound-wave which by instrumentality of a magnetic plate is copied by an electric wave, and this in turn is retranslated into a similar sound-wave. The original sound dies like any other sound, but its photograph, as it were, has been copied in a more subtile medium than air, and so it lives and moves and is born again.

In a few months after its exhibition at Philadelphia, this invention had received such development at the hands of Mr. Bell that subsequent progress has been slow, and the most recent telephones show little improvement over those made a year ago. Bell found that the size and thickness of the vibrating plate, likewise the strength of the battery, could be altered in pretty wide limits without materially changing the loudness of the tones at the receiving station. In his experiments he varied the plate from one inch to two feet in diameter, and from one-sixty-fourth to three-eighths of an inch thick. Between these limits he found the articulation perfect,

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though if too small or too thin the tones had a nasal character, while it sounded like talking into a barrel if the plates were too thick or too broad. Likewise in the battery, he left off one cell after another, until finally all were removed, and still he could talk through the instrument. This was due to residual magnetism as he afterward found, but it led to the abandonment of batteries and the substitution of permanent magnets for the iron cores. This is the form in which the Bell telephone is now used, with no battery and no continuous current, being purely magneto-electric in its principle of action. It must be evident, *prima facie*, that such a telephone can only talk in low tones. Only a small part of the original sound impulse can be changed into electricity, and this in turn can deliver but a small fraction of its force to the ear of the listener. It has been, therefore, from the first, a desideratum to increase the loudness of telephone messages. In quality they were all that could be desired, but the still small voice was hard to be distinguished by unpracticed ears. Hence the long continued experiments of Prof. Bell alluded to. It was found that if an increase was attempted by shouting the original message, the quality of that delivered was much impaired. The sounds, though louder, became indistinct and unintelligible. This was owing to another principle of electro-magnetism, which came into operation in such a case. The electric intensity of telephonic currents depends not only on motion of magnet being directly proportional to velocity of the vibrating plate, but they are inversely as square of distance. Now when the motion of the plate is very small, perhaps chiefly molecular, when moderate tones are used, the variation of distance is so small as to give no appreciable difference on this account; but when the tones are loud, the air-waves give the plate such motion that the law of inverse squares comes in, and the electric pulsation is no longer a faithful copy of the sound-wave.

All attempts, then, to increase loudness by larger battery power, varying the dimensions of the plate, or by increasing the volume of tone at the transmitting station, fail, in great degree, to reach the end sought. Many inventors have tried their skill at this problem without much success. The question then arises, is there not some other way, save by motion of a magnet, of modifying the electric current so that it shall faithfully represent sound-waves?

This leads us to the third class of electric telephones, of which Mr. Edison's inventions furnish the best examples. The genius of Menlo Park, whose fame is world-wide now, owes his reputation most of all to the phonograph, an invention suggested, doubtless, by Bell's telephone, in an attempt to improve the latter. It is not my purpose to discuss this at all, though it is not a little curious that Edison, seeking to improve on Bell's discovery, should incidentally solve Bell's original problem, and, not only that, should also hit on a new line of telephone improvement which vastly increases the possibilities of this invention. All workers with current electricity know how important it is to secure firm metallic contacts in conductors. Here is an invention whose success depends on a loose contact. Edison's merit and success in telephones probably lies chiefly in the invention of the carbon button, which, likewise, is the foundation of the tasimeter and a dozen other novel instruments. It, therefore, merits a special description, easy to give, for it consists simply of compressed lamp-black arising from incomplete combustion of coal oil. It is pressed, with a force of 1,000 pounds to the square inch, into the form of a little disc, one-half of an inch in diameter, and one-sixteenth of an inch thick, the breadth and thickness of an old-fashioned wafer for sealing letters. The carbon button is placed between two metallic discs, which are, in turn, joined to wires forming opposite poles of an electric circuit. The electric current, therefore, passes through the carbon. The discs which form the sides of the

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carbon are so arranged as to be exposed to the influence of sound-waves. These, by their condensations and rarefactions, increase or diminish the contacts of the disc with the carbon, and thus vary the flow of the electric current. This variation is found to be in such exact proportion to these small pressures that an ordinary Bell telephone reports with fidelity a message transmitted by Edison's instrument.

In applying the carbon button to the tasimeter, the heat rays are made to pass through a slit and fall upon a little bar of hard rubber. This is very sensitive to heat, and by its expansion presses on the carbon button, thus increasing the electric current, as witnessed by a delicate galvanometer. Again, the carbon button is used for a new kind of barometer, and also for a hypsometer, to measure the atmospheric moisture. Hughes' microphone employs the same principle of loose contact as the carbon button. It may have a great variety of forms, one of which consists merely of three iron nails — the two being connected directly with the poles of a battery, and the third nail being loosely laid upon these. Another way is: Make a box with tin plates passing into the interior on opposite sides, which are thus connected with the poles of a battery. The box is now filled with gas cinders, and becomes a microphone. Three or four of these hung on the walls of a room, like picture frames, were sufficient to transmit conversation going on in the room, thus realizing not only the idea that walls have ears, but mouths, too.

Time does not allow even an allusion to the many modifications that have been made in the forms of the last two classes of telephones. In spite of all that has been done, distinct articulation by telephones can be given, as yet, only in comparatively low and feeble tones, and we yet wait for Edison, or some other genius, to complete the instrument which will deliver popular harangues or concerts, and report speeches. Aside from any direct practical applications, there is a wide field of interest in the purely scientific aspect of telephones. Through them we see the inner workings of molecular forces from a new and most interesting standpoint.

We discover new evidence of the marvelous delicacy of the ear, and, conjoined with the kindred invention, the phonograph, we are possessed, for the first time, of the means for making a complete scientific analysis of speech, and may hope to make record of this fugitive aerial movement, which has hitherto been lost like the track of a vessel through the sea. Finally, the telephone teaches the wonderful potency of little things, and that many forces we count as lost go on and on, and return, perhaps, at last, to their origin, after cycles of change.

AMBLYCHILA CYLINDRIFORMIS *SAY.*

By Prof. FRANK H. SNOW, of the University of Kansas.

In considering the unintelligibility of the title of this article to one who is not a professional entomologist, I am reminded of a brief dialogue which occurred between Mr. Richard Foster, a member of my last summer's collecting party, and a cow-boy of the plains, who passed by one evening while Mr. Foster was looking for specimens. After watching him for some moments with great curiosity the cow-boy asked: "What are you doing?" Mr. Foster replied: "Hunting Ambly-

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chila." The cow-boy in great amazement inquired again: "Ambly Chila—who's *she?*" Who "she" is, it will be the object of this paper in some measure to explain.

In 1823 the famous entomologist, Thomas Say, discovered a single dead specimen of this insect "near the base of the Rocky Mountains." Twenty-nine years later a second specimen, also dead, was found upon the "Llanos Estacados," or Staked Plains, by one of the United States surveying expeditions. The remarkable structure and great rarity of this beetle made it "*facile princeps*" among American insects, and its possession was eagerly sought by our foremost entomologists. But many difficulties lay in the pathway of those who would gain the coveted prize. The regions in which the two specimens had been captured were practically inaccessible to the entomologist. No railroad had then entered the vast country lying west of the Missouri river, and hostile bands of Indians were at all times in readiness to massacre the reckless adventurers who should dare to traverse their hunting grounds without a powerful military escort. A national expedition for the survey of our immense unoccupied domains might obtain the needed protection by Government authority. But what professional "bug-hunter" could hope for membership in such an expedition, much less aspire to the requisite military escort for an expedition of his own for the sole purpose of hunting an insect, however rare and however valuable in the estimation of entomologists. But, notwithstanding the inaccessibility of the plains to collectors of insects, various attempts were made to overcome this difficulty. A distinguished American entomologist, not many years after the discovery of the second specimen of Amblychila, in 1852, printed a circular containing a description and life-size figure of the beetle, which he distributed among the army surgeons at the various military posts in the Western territories. Several additional specimens were in this way obtained, and several others were brought in by some of the more recent Government expeditions. But *Amblychila cylindriformis* continued to be the rarest and the costliest of American insects. It could hardly be purchased for museums at any price, and not more than two years ago, no less than fifteen or twenty dollars were eagerly paid for a single specimen. Indeed, a price list of North American coleoptera issued at Cambridge only eight months ago, quotes the subject of this paper at twelve dollars per specimen.

Two causes, however, have recently conspired to bring out the fact that this insect is by no means the same rarity in nature as in entomological collections. In the first place, the withdrawal of the Indian tribes from Kansas soil to distant reservations, has made it possible for the collector of insects to visit the plains without incurring the imminent danger of losing his scalp; and in the second place, the discovery of the crepuscular and nocturnal habits of *Amblychila* has led to the capture of great numbers of specimens during the past season. This discovery, which had been predicted by Dr. LeConte, of Philadelphia, was actually made in the summer of 1876 by Messrs. H. A. Brous and S. W. Williston, of the Yale College geological expedition to Western Kansas, in charge of Prof. B. F. Mudge. The members of this party obtained about 100 specimens. During the present season several hundred specimens have been collected by Messrs. Williston and Cooper, of the Yale expedition, and by the Kansas University expedition in charge of the writer. It is more than probable that the present year has been unusually favorable to the occurrence of this insect, and that the next season may prove, like that of 1876, less productive of specimens. It is a well known fact that a species may occur in great abundance for one year and then become comparatively rare or altogether unknown for several years in succession. This

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law will doubtless be found to apply to *Amblychila cylindriformis* as well as to other insects.

I was disappointed to find these insects apparently devoid of that intensely ferocious nature which had been ascribed to them by sensational writers for the Eastern press, and which would be suggested by its position at the head of a ravenous family, the *Cicindelidæ*, or Tiger-beetles. I have watched them night after night coming forth from their hiding-places soon after sundown and beginning their night-long search for food. I am satisfied that their sense of sight must be exceedingly deficient, as they never discover their prey from a distance, however slight, and never capture it unless stumbling upon it as if by accident. When, however, they do thus stumble upon an unfortunate caterpillar, grasshopper, or other suitable article of food, a very acute sense of touch, chiefly concentrated in their long and constantly vibrating antennæ, enables them to seize upon and firmly hold it with their powerful mandibles, while with their maxillæ or secondary jaws they withdraw the life juices and soft tissues of their struggling victim. They also manifest the imperfection of their vision by making no attempt to escape from their human captors, allowing themselves to be picked up as if entirely blind. They are slow in their movements, walking about with great deliberation over their favorite hunting grounds, the sloping clay-banks. The only approach to rapidity of movement observed during the summer was in the case of a single individual surprised by the morning sun while at a distance from a suitable hiding place which he was making frantic exertions to discover.

In a brief paper contributed to this Academy by Mr. H. A. Brous, at our last annual meeting, it was stated that *Amblychilæ* live in holes which they construct for themselves. My own observations do not corroborate this statement. On the other hand, I found them invariably coming forth at night from holes made by other animals, most especially from the intricately winding burrows of the kangaroo rat (*Dipodomys Phillippii*), by which the clay banks are often completely honeycombed. In these burrows they take refuge from the direct rays of the sun in the daytime, in company with other nocturnal genera—*Eleodes*, *Pasimachus*, etc. These latter insects undoubtedly furnish many a midday meal for *Amblychilæ*, which are not to be supposed to pass the entire day in sleep. On one occasion I had an opportunity of watching two of them in a large abandoned badger's hole. They were wide awake and walking about with vibrating antennæ as if in search of food. I have also kept several living specimens in confinement and have carefully watched them for several weeks, but never discovered any disposition to make excavations for themselves, though they would gladly take possession of holes made for them in the earth at the bottom of the cage.

In regard to food, no living insect seems to come amiss to them. They seem to be especially fond of all sorts of Orthopterous and Lepidopterous larvæ. They will attack and devour the huge wingless locusts (*Brachypeplus*), and sword bearers (*Ensicaudes*). I have seen them in the act of conquering and devouring the large Prionus of the plains (*P. fissicornis*), and in two instances have seen them eating one another, apparently with the keenest relish. In confinement they will thrive upon full grown maple-worms (*Dryocampa rubicunda* var. *alba*), the caterpillars of the Hand-maid Moth (*Datana ministra*), and almost every other insect pest of the orchard and garden.

But while thus visiting the death penalty upon every member of his class with which he comes in contact, our voracious hero is himself a choice article of diet to at least one carnivorous quadruped of the plains. Mr. John M. Walker, one of the members of my party, while patroling his accustomed beat one morning

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before sunrise, discovered the fresh fragments of several half-eaten *Amblychilæ* scattered along his route, as if some predatory animal had but just preceded him and made his breakfast upon the rarities which otherwise would have made their way into the collecting-bottle. On the evening of the same day, Mr. Walker, while collecting in the same locality, was violently attacked by a rabid skunk, twice in immediate succession. The next morning Mr. Richard Foster, the other student of the party, was similarly attacked on a neighboring clay-bank, and had the good fortune to kill his assailant. An examination of the contents of this animal's stomach revealed unmistakable remains of freshly-eaten *Amblychilæ*. It would thus appear that this ill-odored quadruped has an original claim to the title of "Amblychila-hunter," and is ready at the proper time to vindicate its claims against human contestants. This fact will merit the serious consideration of entomologists who may hereafter visit the plains, since the bite of the rabid skunk has proven fatal to man in more than nine cases out of ten, and there are more than fifty fatal cases on record. In this connection may be mentioned another danger which must be incurred by the collector of insects upon the plains. I refer to the bite of the rattlesnake, which venomous reptile abounds in Western Kansas and Eastern Colorado, and was encountered nearly every day by some member of our expedition.

NOTE ON THE HABITS OF SOME OF THE RARER CICINDELÆ.

By S. W. WILLISTON, New Haven, Conn.

The few following observations may be of use to collectors:

C. montana. This species I found in considerable quantities early in spring, in Southern Wyoming—more frequently along the hillsides or uplands, and not especially in bared ground.

C. pulchra. This beautiful species is extremely abundant in Southeastern Kansas and Southern Colorado. They always choose perfectly bared spots of loam, on high ground, and for that reason are oftenest seen along old unused roads. A peculiarity of their northern distribution is interesting. They are extremely abundant along the valley of the Smoky Hill river, extending nearly as far east as Ft. Hays. But during three years of active collecting in the West by Messrs. Brous, Cooper, E. W. Guild, and myself, I never learned of a specimen taken north of the divide between the Smoky Hill and Saline rivers, nor indeed beyond the immediate valley of the Smoky Hill. Another beetle with almost precisely the same limits of distribution, is *Asida elata. Amblychila cylindriformis*, although occurring very rarely north of the Smoky Hill, does still reach the Solomon river.

C. scutellaris. Smoky Hill and Saline, confined mostly to sandy streams on the borders near vegetation, but nearer the open sand than *formosa.*

C. 10-notata. Has habits somewhat similar to *montana*, specially distributed in Southern Wyoming, on high grounds among the buffalo grass.

C. Auduboni. Most abundant in early spring. The black variety was most commonly seen in the open clayey bottoms of ravines and hollows near the chalk

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washes, and not usually intermingled with the green variety. Both varieties, or sub-varieties, were found on the Laramie plains.

C. fulgida. This beautiful species I have found abundant in Western Kansas and Southern Wyoming. They frequent the upper banks, contiguous, but at some distance from water, among the buffalo grass. Their quick flight, together with the unbared situation, render it difficult to obtain them in numbers.

C. hyperborea. Common at Como, Wyoming, near the lake's edge, with *vulgaris.*

C. circumpicta. This species seems to be confined to bared alkaline spots, at least it has been in such localities that I have taken them in Western Kansas and Nebraska.

A PARTIAL LIST OF THE FISHES OF THE MARAIS DES CYGNES, AT OTTAWA.

By PROF. WM. WHEELER.

I. PERCIDÆ—PERCHES.

1. *Stizostedium Americanum* (Gill)—Wall-Eyed Pike.

II. ICTHELIDÆ—SUNFISHES.

2. *Pomoxys hexacanthus* (Agassiz)—Six-spined Bass; abundant.
3. *Micropterus nigricans*—Black Bass.
4. *Pomotis auritus* (Gun.)—Bream; plentiful.
5. *Pomotis luna* (Agassiz)—Moon Sunfish.

III. SCIÆNIDÆ—DRUMS.

6. *Haploidonotus grunniens* (Raf.)—Drum; abundant.

IV. CLUPEIDÆ—HERRING.

7. *Dorosoma Cepedianum* (Gill)—Hickory Shad; abundant.

V. CATASTOMIDÆ—SUCKERS.

8. *Hypentelium nigricans* (Jordan)—Mud Sucker.
9. *Erimyzon melanops* (Jordan)—Striped Sucker.
10. *Moxostoma duquesnei* (Jordan)—Red Horse; abundant.
11. *Carpiodes bison* (Agassiz)—Buffalo Carp; abundant.
12. *Ichthyobus bubalus* (Agassiz)—Brown Buffalo; abundant.
13. *Bubalichthys niger* (Agassiz)—Buffalo; abundant.
14. *Catostomus teres* (LeS.)—White Sucker.

VI. SILURIDÆ—CATFISHES.

15. *Ictalurus punctatus* (Jordan)—Channel Cat; abundant.
16. *Amiurus nigricans* (Jordan)—Great Lake Cat.
17. *Amiurus atrarius* (Gill)—Horned Pout; abundant.
18. *Amiurus albidus* (Gill)—Western Bullhead.
19. *Hopladelus olivaris* (Gill)—Mud Cat; abundant.

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VII. LEPIDOSTEIDÆ—GAR PIKES.

20. *Lepidosteus osseus* (Agassiz)—Long-nosed Gar.
21. *Cylindrosteus platystomus* (Grd.)—Short-nosed Gar.

VIII. PETROMYZONTIDÆ—LAMPREYS.

22. *Petromyzon argenteus* (Kirtland)—Silvery Lamprey.

LIST OF KANSAS SNAKES IN THE MUSEUM OF THE KANSAS STATE UNIVERSITY.

Prepared by ANNIE E. MOZLEY, Class of 1878, State University.

COLUBRIDÆ.

EUTAINIA.

1. *E. sirtalis*, B. and G. Striped Garter Snake. Douglas county.
2. *E. sirtalis*, variety *dorsalis*, B. and G. Douglas county.
3. *E. saurita*, B. and G. Swift Garter or Riband Snake. Douglas county.
4. *E. parietalis*, B. and G. Douglas county.
5. *E. Marciana*, B. and G. Douglas county.
6. *E. proxima*, B. and G. Wallace county. Collected by Prof. Snow.
7. *E.* ———. Specimen referred to Eutainia, but disagrees with genus in having but two postorbitals, and in having very short tail. Douglas county. Very common.

NERODIA.

1. *N. sipedon*, B. and G. Water Snake. Douglas county,
2. *N. Holbrookii*, B. and G. (?) Holbrook's Water Snake. Douglas county.

REGINA.

1. *R.* ———. Specimen referred to Regina, but differs from it in having more than 162 abdominal scutellæ. Probably a new species. Douglas county. Collected by F. H. Morgan.

HETERODON.

1. *H. simus*, B. and G. Hog-nose Snake. Wallace county. Collected by Prof. Snow.
2. *H. nasicus*, B. and G. Hog-nose Snake. Wallace county. Collected by Prof. Snow.
3. *H. cognatus*, B. and G. Blowing Viper. Douglas county.
4. *H. atmodes*, B. and G. Blowing Viper or Spreading Adder. Douglas county.

PITUOPHIS.

1. *P. Sayi*, B. and G. Bull Snake, or Western Pine Snake. Douglas county.

SCOTOPHIS.

1. *S. alleghaniensis*, B. and G. Pilot Snake. Racer. Douglas county. Collected by W. G. Raymond.

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2. *S.* ———. Referred to Scotophis, but does not agree in all particulars Douglas county.

OPHIBOLUS.

1. *O. calligaster*, Say. Kennicott's Chain Snake. Douglas county.
2. *O. getulus*, variety *Sayi*, B. and G. King or Egg Snake. Douglas county. Collected by Mr. J. Savage.
3. *O. eximius*, B. and G. House, Milk or Chicken Snake. Douglas county.
4. *O. gentilis*, B. and G. Wallace county. Collected by Prof. Snow.
5. *O.* ———. Species not determined, probably new. Douglas county.
6. *O.* ———. Calico Snake. (Snow.) Species not determined. Agrees with *O. doliatus* in having the head red; with *O. gentilis* in having sides blotched; differs from both in having thirty-five pairs black rings. Very common. Douglas county.

BASCANION.

1. *B. constrictor*, B. and G. Black Snake. Douglas county.
2. *B. Foxii*, B. and G. (?). Douglas county.
3. *B. flaviventris*, Say. Blue Racer. Very common in Douglas county.

MASTICOPHIS.

1. *M. flavigularis*, B. and G. Coach-whip Snake. Wallace county. Collected by Prof. Snow.

DIADOPHIS.

1. *Diadophis punctatus*, Linn. Ring-necked Snake. Douglas county. Collected by Prof. Snow.

CELUTA.

1. *C. vermis.* Worm Snake. Douglas county.

CROTALIDÆ.

CROTALUS.

1. *C. confluentus*, Say. Osborn City. Collected by R. B. Foster.
2. *C.* ——— (?). Differs from any specimen described by Baird and Girard in having but twenty-one rows of dorsal scales. The general color is light cinnamon; skin between scales, sulphur yellow. The transverse dorsal bands, twenty-five in number, are black, very short, only two or three scales longitudinally. Dorsal line, of chestnut, three scales wide. Tail black; abdomen white; sides of scutellæ mottled with black; cheeks white. Douglas county. Obtained by Prof. Snow.

CROTALOPHORUS.

1. *C. tergeminus*, B. and G. Prairie Rattlesnake. Massauga. Douglas county.

AGKISTRODON.

1. *A. contortrix*, B. and G. Copperhead. Douglas county.

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ON THE BITE OF THE RATTLESNAKE.

By JOSEPH SAVAGE, of Lawrence.

It has fallen to my lot to narrate to you, briefly, some of the experiences of our worthy President, Prof. F. H. Snow, while suffering from the bite of a rattlesnake, which occurred during his expedition upon the plains of Western Kansas, last summer.

The party were in camp about fifteen miles south of Buffalo station, upon a small stream known as Hackberry creek. There were in the party Profs. Snow and Mudge, with students Foster and Dyche. The bite was received upon the twenty-seventh day of June, 1878. The circumstances attending it came about in the following manner:

In the morning Prof. Snow went from camp about two miles, to what is known as Cathedral Rock; this rock is a high bluff and a prominent landmark in all that region. He was here alone, until about eleven o'clock, when he returned to camp, holding a small rattlesnake in his left hand, and in his right he had a portion of the vertebral column of a fossil fish, somewhat distorted into the shape of a good sized pistol. The Professor remarked, playfully, as he reached camp, that he had a snake in one hand and a pistol to shoot it with in the other. The snake had three rattles and a button. It was decided, after some debate, to put the snake into alcohol for preservation. For this purpose a bottle with a long, small neck was produced, and after some further discussion as to methods, it was thought safest to introduce the snake into the bottle tail foremost. To this the snake objected, and in the struggle between the man and the snake, in an unguarded moment, the right hand was held above the head of the snake, when the venomous reptile, with the coils of its tail placed firmly against the neck of the bottle, darted upward with one convulsive spring, taking with it the left hand and arm of its captor, and buried its poisonous fangs in the tip of the second finger of the right hand. Now, almost all men have, from habit, some ejaculation which will gush forth in times of excitement without their consent; so it was with the subject of this story, and out it came: "By George, he has bitten me." As quick as thought the reptile was thrown upon the ground and held in place by the foot, while the poor bleeding finger was instantly placed in the mouth and vigorously sucked.

Both our President and Vice-President expressed themselves pleased with having a long-cherished desire gratified of seeing the effects of a rattlesnake bite. The latter gentleman, however, expressed his willingness to have the bite on some one besides himself, while the former submitted to the inevitable without grumbling. A string was immediately tied around the bitten finger, just above the knuckle, and the bite was soon lanced, to let the blood flow more freely. The pain from the bite was very severe, the most intense of any ever before experienced, and was compared to having a hundred hot needles thrust into one's flesh, all at once. The subject of the bite had had the nerve of a tooth pulled out by a dentist, the pain of which was as nothing compared to this pain from the bite. In two or three minutes the intensity of the pain subsided into a good sound wholesome ache, which, after twenty-four hours, entirely ceased. In a few moments after the bite, the finger had swollen to nearly twice its usual size, and had turned nearly black; it was then lanced upon one side, relieving it somewhat; after another half hour it

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was lanced again upon the other side, affording more relief. In about three minutes after the bite, the patient grew slightly faint, and lay down upon the ground awhile, during which period Prof. Mudge, with one of the students, continued sucking the wound.

One hour after the bite, the string was removed from the finger, after which the hand and wrist swelled up to about twice their natural size, and the arm became much discolored. The swelling had entirely subsided in forty-eight hours, but the discoloration continued for a week. The wound caused by the bite healed in two weeks, without loss of the nail. The nail, however, from some cause, showed a black spot upon it, just opposite the bite, which spot has just disappeared three months afterward. The pulse of the patient, five hours after the bite, had fallen down to fifty per minute; two hours later it had risen to fifty-six; the next morning it was beating at sixty, and in twenty-four hours it had regained its usual rate. It may be also interesting to note, that Prof. Snow responded promptly to the dinner-call, and ate so much more than usual, that the cook suggested that a few more snake bites in camp would exhaust the supply of food on hand, and an extra trip to the station for supplies would be inevitable. To the surprise of all, the Professor was out all the afternoon, collecting as eagerly as though nothing unusual had happened to him.

In regard to the number of rattlesnakes killed during a sojourn of thirty days upon the plains, only fifteen are recorded.

It should also be stated that Prof. Mudge took the snake in charge while Prof. Snow was lying down, and put it into the bottle head-foremost, without any apparent difficulty, so now our President can not only inform his classes in natural history the best method of treating a rattlesnake bite, but also inform them of the latest and most approved style of bottling them.

Another rattlesnake bite came under the special notice of the writer, in the harvest field of his brother, Mr. Forrest Savage.

It was received by one of the harvest hands, Mr. George Risley, while engaged in binding wheat during our last summer's harvest. The reaper had just passed over the snake, and Mr. Risley was binding close behind it. The bite was received on the second finger of the right hand, just above the knuckle-joint, while in the act of taking up a gavel for binding. The snake seemed to be concealed beneath the bundle, and was probably irritated somewhat by the previous passage of the reaper near its resting place, or, it may be, over a part of its body. Mr. Risley describes the bite as a blow, accompanied by a hot, burning sensation. When he withdrew his hand from underneath the grain, the snake followed with its fang still buried in his finger. A single jerk of the arm failed to release its hold, and not until a second and more vigorous motion of the arm did the reptile's fang tear its way from the cuticle of the finger; and now, six months afterwards, a large scar marks the place where the bite was given. The snake was killed—it had six rattles and a button. The alarm was immediately given to the other hands in the field, and a man was dispatched at once to the nearest house—that of Mr. Bates—for whisky. About a pint was obtained and swallowed, as Mr. Risley expresses it, "straight."

By this time—about ten minutes after the bite—the arm had swollen to about twice its natural size, and had turned to a very dark and mottled color. The whisky reduced the swelling almost instantly, and partially restored it to its natural color. The swollen arm was then tightly bandaged, and the young man was soon carried in a buggy, the distance of two miles, to his home. Arriving home, his over-anxious friends administered about as much more whisky as was taken in the field. Then the patient became unconscious and almost unmanageable until the

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next morning, when he describes the pain of his scalded throat, and his burning thirst, as almost intolerable.

Dr. May was called to treat the case, which he did in the usual way of cauterizing the wound, and freely applying iodine to the affected arm. The patient kept his room for about two weeks, with loss of appetite, and general debility; after which he carried his hand in a sling, and suffered much from numbness and lack of feeling in the bitten finger. It has now entirely recovered its wonted consciousness, and Mr. Risley insists that if he ever binds wheat again it shall be done with gloves on both his hands.

ADDITIONS TO THE CATALOGUE OF KANSAS BIRDS.

By Prof. F. H. SNOW, University of Kansas.

The third edition of the Catalogue of Kansas Birds contained 295 species. The following additions have since been made:

296. *Neocorys Spraguei* Aud. Missouri Skylark. This species was taken at Ellis, by Dr. Louis Watson, Nov., 1877. Dr. Watson states that his specimen was found solitary, but that he is satisfied that this species is "not rare in Ellis county—present every winter, and in company with Shorelarks and Longspurs."

297. *Melanerpes torquatus* Wilson. Lewis's Woodpecker. Also taken at Ellis by Dr. Watson, May 6th, 1878. One specimen was obtained from a flock of six or eight.

298. *Nyctiardea violacea* Linn. Yellow-crowned Night-Heron. Taken at Neosho Falls by Col. N. S. Goss, who killed three young birds and one adult female in breeding plumage, with eggs nearly full-formed in the ovaries.

299. *Ardea caerulescens* Linn. Blue Goose. This species also was taken by Col. Goss at Neosho Falls. One bird was killed from a flock of ten or twelve.

300. *Xema Sabinei* Sab. Fork-tailed Gull. A single specimen, a young male, flew late at night through the open door of Peter Long's saloon, at Humboldt, Sept. 19, 1876. Reported to me by Col. N. S. Goss, who secured the specimen for his cabinet.

301. *Sterna hirundo* Linn. Wilson's Tern, or Common Tern. This species was in the first edition of the Birds of Kansas, but was stricken out from subsequent editions from fear that it had been confounded with Forster's Tern. It is now restored to the list by Col. N. S. Goss, who procured a specimen in Anderson county.

302. *Pyrgita domestica* Linn. The English Sparrow. This bird has become an abundant resident of Topeka, having been introduced by Hon. F. C. Giles in 1874. A small flock of about a dozen birds has been observed by the writer in Lawrence.

To this list may be added the following varieties of species already catalogued:

55*a*. *Icteria virens*, var. *longicauda* Lawr. Taken along the Smoky Hill river in Western Kansas, by S. W. Williston, in May, 1877.

190*a*. *Buteo Borealis* Gen. var. *calurus*. Western red-tail. Taken at Ellis, Lawrence and Nesho Falls.

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ON THE ADULT MALE PLUMAGE OF WILSON'S PHALAROPE.

(*Steganopus Wilsoni* Sab.)

By S. W. WILLISTON, New Haven, Conn.

From careful observations the present season in Southern Wyoming, I became well satisfied that what has been hitherto considered the young plumage of this bird, has been confounded with the adult male. The birds first made their appearance in the vicinity of Lake Como, May 5th, and afterwards became somewhat abundant, breeding in the marshy lands during June. A perfectly formed egg was taken from the oviduct of a female, June 8, although search for the nests was unsuccessful. The plumage here given is based upon the uniform result of seventeen dissections, in which the female plumage was invariably as given in Dr. Coues' excellent Key to North American Birds.

Steganopus Wilsoni male. Crown dark, nearly the color of the lesser wing coverts, somewhat ashy on the occiput and nape. Forehead lighter. The stripe running from bill, back through the eyes, so characteristic of the female, is faint, and nearly the color of the forehead. The cinnamon stripe on either side of the neck, is faintly marked and speckled with ashy; breast and fore part of the neck more purely white than in the female. The interscapulars, and many of the scapulars black edged with tawny. Upper tail coverts brown, bordered with white; otherwise as in the female.

The absence of black, and the deep rich cinnamon upon the neck and scapulars, together with dark markings of the crown and back, render the plumage strikingly different from the female, and I could hardly believe, till after repeated dissections, that this soberly marked bird was the adult mate of the so richly colored female. The birds are so confiding in their habits, that after I had shot nearly a score, I forebore their further destruction, but watched them as they circled in graceful flight about me, or swam so lightly in the water. I invariably distinguished the different plumage of the pairs.

That they should have shown without exception, when at last a year old, the adult plumage in the female, and the young plumage in the male, seems wholly improbable, and I doubt not that future observation will confirm my discovery.

No words can convey the beautiful and graceful forms of these birds, as they swim so lightly about upon the water. They prefer the small marshy ponds, and never venture upon rough water. The nearly related *Lobipes hyperboreus*, on the other hand, delight in deep water, rising and falling upon the high waves, far beyond the reach of fire-arms.

SPERMOPHILUS RICHARDSONII.

By S. W. WILLISTON.

I watched with considerable interest, the present season, the habits of this spermophile on the Laramie plains, where they exist in great numbers. They were seen very early in the spring, feeding upon the first green things that appeared,

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and their burrows through the sand leave permanent rounded ridges of dirt. They bring forth their young early in May, gravid females being found as late as the second of the month. The first appearance of the young above ground was about the twentieth. Five was the largest number noted in one litter. The burrows do not descend far into the ground; one that was followed for ten feet was in no place more than twenty inches from the surface. They throw little or no dirt out from their burrows, choosing their entrances from little mounds, especially among the sage brush. The burrows frequently have more than one opening, but not always. In one case the young were driven out more than forty yards away from the hole in which water was poured. I caught, in this way, a dozen or more of the little fellows, taming them with but little difficulty, they readily feeding from my hands on crackers, cheese or grass. They were especially fond of milk, which they drank in large quantities. They spent most of the time in sleep, and although not very playful, were most interesting pets, scolding vehemently when annoyed. One of them finally learned the trick of raising a wire in his cage and escaping, repeating it several times, till but five were left. The last time they nibbled some poisoned bird skins, and died from the effect.

They will frequently climb high up in the sage bushes, and sit quietly feeding upon leaves or grass that they have carried. They certainly never from choice feed upon sage leaves. In the latter part of July they lose nearly all timidity in their eager search for winter's food, entering the open doors to pick up crumbs thrown from the table, and scrambling over one's feet in their restless eagerness. I have been told by several competent observers, that before the close of August they suddenly and completely disappear, not to again show themselves before the following spring.

It seems to me very probable that many of the spermophiles undergo a more or less semi-torpid hibernation during the winter months. A species common through Kansas (*tridecemlineata*) I have frequently tamed. The young make their appearance late in May, and within a few minutes after being caught, will be eating contentedly from one's hand. Three thus tamed were unintentionally left exposed one frosty night. The next morning I was very sorry to find my pets cold and without the least sign of life. I threw them forcibly away, and my amazement was great when, a few hours later, the cat brought one in not yet dead. Searching for the other two, I found them and replaced them in their cage, where they were soon eagerly feeding. I afterwards found them susceptible to the same torpor for many hours at a time, when exposed to the cold.

BOTANICAL ADDENDA.

By PROF. J. H. CARRUTH.

Since the "Centennial Catalogue of the Plants of Kansas" was prepared, nearly a year has elapsed, and I am able to add the following species. I am indebted to Mr. B. B. Smyth, of Ellinwood, Barton Co.; to Mr. James Wilson, now at Arkansas City, Cowley Co.; to Mr. Joseph Henry, of Salina; to Prof. Wherrell, of Leavenworth; to some person unknown, but probably from the southeast corner of the

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State, and a few others, for plants; and to Mr. E. Hall, of Athens, Ill., and S. H. Wright, M.D., of Penn Yan, N.Y., for aid in determining several of them. Those I have credited to Mr. Popenoe I give on his authority. Apprehending a scarcity of space, I shall omit the orders and the common names. In two or three cases I am unable to give the authorities.

1084. *Cleome pungens* L. Shawnee county. Popenoe.
1085. *Cleomella angustifolia* Tor. Ellin.
1086. *Hypericum pyramidatum* Ait. Leav.
1087. *Hypericum prolificum* L. Law.
1088. *Cerastium vulgatum* L. Var. Ark. City.
1089. *Petalostemon villosus* Gr. Ellin.
1090. *Astragalus scopulorum* Porter. Ark. City.
1091. *Phaseolus perennis* Walt. Sal.
1092. *Potentilla arguta* Ph. Ark. City.
1093. *Gillenia stipulacea* Nutt. Southeast Kan.
1094. *Ammania humilis* Mx. Law.
1095. *Œnothera Fremontii.* Rooks county.
Mr. Popenoe found two specimens with three petals, six stamens, and pistil three-parted.
1096. *Opuntia fragilis.* Ellis; from Dr. Watson.
1097. *Diodia teres* Walt. Near Big Springs, Douglas county.
1098. *Solidago nemoralis* Ait. Law., Ellin.
1099. *Silphium Asteriscus* L. [?] Law.
1100. *Xanthium spinosum* L. Leav.
1101. *Gaillardia aristata* Ph. Sal. Popenoe.
1102. *Hymenopappus scabiosæus* L'Her. Ark. City.
1103. *Leucanthemum vulgare* Lam. Law.; from Miss Jennie Ricker.
1104. *Cirsium lanceolatum* Scop. Leav.
1105. *Pyrrhopappus Carolinianus* D C. Ellin.
1106. *Vaccinium stamineum* L. Possibly *arboreum*, Leaves only. S. E. Kan.
1107. *Dodecatheon Meadia* L. S. E. Kan.
1108. *Pentstemon glaucus*? Grah. Ark. City.
1109. *Collinsia parviflora* Doug. S. E. Kan.
1110. *Hedeoma pulegioides* Pers. Law.
1111. *Scutellaria versicolor* Nutt. Leav.
1112. *Lithospermum latifolium* Mx. Leav.
1113. *Convolvulus arvensis* L. Topeka; Popenoe.
1114. *Asclepias phytolaccoides* Ph. Leav.
1115. *Gonolobus obliquus* Br. S. E. Kan.
1116. *Rumex orbiculatus* Gr. Ark. City.
1117. *Rumex conglomeratus* Murr. S. E. Kan.
1118. *Rumex obtusifolius* L. Leav.
1119. *Rumex maritimus* L. Leav.
1120. *Chenopodium Botrys* L. Law., Leav.
1121. *Amarantus spinosus* L. Leav.
1122. *Stillingia sylvatica* L. Ark. City.
1123. *Potamogeton hybridus* Mx. Law.
1124. *Sagittaria lanceolata* L. Sal. Law.
1125. *Smilacina racemosa* Desf. Leav., from Mr. C. M. Arbuthnot.
1126. *Pardanthus Chinensis* Ker. Leav.
1127. *Zygadenus glaucus* Nutt. Waubaunsee, from Mrs. S. M. Thomas.

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1128. *Zygadenus leimanthoides* Gr. Ark. City.
1129. *Juncus Balticus* Dethard, *var.* Ellin.
1130. *Cyperus stenolepis* Torr. Sal.
1131. *Cyperus Engelmanni* Steud. Law.
1132. *Cyperus Lancastriensis* Porter. Law.
1133. *Eleocharis obtusa* Schultes. Law.
1134. *Scleria triglomerata* Mx. Law., Leav.
1135. *Carex aristata* R. Br. Ellin.
1136. *Carex Douglasii* Boott. Ellin.
1137. *Carex angustata B. strictior* Dewey. Ellin.
1138. *Aristida purpurascens* Poir. Sal.
1139. *Calamagrostis longifolia* Hook. Ellin.
1140. *Panicum* [*Paspalum?*] *glabrum* Gaud. Topeka; Popenoe.
1141. *Panicum villosum* Ell. Sal.
1142. *Panicum dichotomum* var. *sphærocarpum* Law. var. *barbulatum* Law.
1143. *Tricuspis ambigua* Ell. Topeka; Popenoe.
1144. *Festuca ovina* L. var. *brevifolia*, possibly *duriuscula* fls. 9. Ark. City.
1145. *Eatonia Pennsylvanica* D C. Law., Ark. City.
1146. *Poa serotina* Ehrh. Ellin.
1147. *Glyceria Canadensis* Trin. Law., Ellin.
1148. *Equisetum lævigatum* Braun. Sal.

AMERICAN JURASSIC DINOSAURS.

By S. W. WILLISTON, New Haven, Conn.

The recent discoveries of abundant Dinosaur remains in the Rocky Mountain region, has given a renewed interest to the study of this singular order of extinct reptiles. Since the discovery, in March, 1877, of fragments of these animals in the upper Jurassic beds of Colorado and Wyoming, there have been exhumed not less than thirty tons of their remains, an amount probably exceeding all hitherto brought to light, both in Europe and America. The larger proportion of these collections are now in the museum of Yale College, and the remainder in Philadelphia, where, from their future study by the indefatigable paleontologists, Marsh and Cope, the final solution of their structure and affinities may be confidently expected.

The history of their discovery is both interesting and remarkable. For years the beds containing them had been thoroughly studied by geologists of experience, under the surveys of Hayden and King, and their position and extent carefully described and mapped out, but yet, with the possible exception of the half of a caudal vertebra, obtained by Hayden, and described by Leidy as a species of *Poikelopleuron*, not a single fragment had been recognized! This is all the more remarkable from the fact that in several of the localities, thus mapped out, I have observed acres, literally strewn with fragments of bone, many of them extremely characteristic, and so large and conspicuous as to have taxed the strength of a strong man to lift them! Three of the localities known to me are in the immediate

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vicinity, if not upon the actual town-sites, of thriving villages, and for years numerous fragments have been collected by tourists, and exhibited as specimens of petrified wood! The abundance and wide extent of their remains is almost incredible. The quantities hitherto obtained, although apparently so vast, are wholly unimportant in comparison with those yet awaiting the researches of geologists, throughout the entire Rocky Mountain region; I doubt not that many hundreds of tons will eventually be exhumed.

To an English geologist, Prof. Arthur Lakes, of Golden, Colorado, credit is due for first detecting the osseous character, and appreciating the scientific value, of these fossils. While engaged one day, in March, 1877, in company with Engineer E. L. Berthoud, of Colorado, in collecting Dakota leaves from the summit of the ridge, or "Hog-back," near Morrison, he discovered a huge caudal vertebra in bas-relief upon a slab of sandstone. Upon further investigation, a large quantity of bones were collected and shipped to Prof. Marsh, of Yale College, by whom they were described under the name of *Titanosaurus montanus.*

Almost contemporaneously with this discovery, the fossils were made known at Canyon City, Colorado, by Mr. O. Lucas, a school teacher, and in Southern Wyoming by Mr. Wm. Reed, an intelligent section foreman of the Union Pacific Railroad. Specimens from the former locality were sent to Prof. Cope, of Philadelphia, by whom they were named *Camerasaurus supremus.* Since then numerous other localities have become known in Colorado and Wyoming, and I doubt not but that future explorations will bring to light scores of outcrops rich in these vertebrate remains.

The beds consist of argillaceous shales of a grayish, or bluish gray color, variously interspersed with sandy, or sandstone strata, of from four to six hundred feet in thickness, the fossils extending through at least 300 feet in a vertical altitude. At Canyon City the deposits lie immediately upon the characteristic red sandstones of the Trias, the fossils having been detected to within seventy-five feet of the conglomerate. The beds are apparently conformable, as shown by the erosion of the valleys of two small streams, lying in a synclinal basin, the ridges of which are convergent, thus giving a transverse strike to the uneroded strata between the valleys.

Skirting the eastern flanks of the foothills, and extending for several hundred miles through Colorado and Wyoming, is a prominent ridge, or "Hog-back," of several hundred feet in height, dipping often at an angle of from 40 to 60 degrees, and usually protected above by the hard leaf-bearing sandstone of the Dakota cretaceous. Along the western slope of this ridge the fossiliferous clays or sandstones are usually concealed beneath the debris washed over them, but whenever exposed, as is often the case on the sides of valleys cutting through the Hog-back, fragments of dinosaur bones may generally be detected. Such is the case at Morrison, near Denver, where large quantities have been collected for the museum of Yale College. The fossils here extend to within at least 200 feet of the well-defined Dakota sandstone. Here, however, below the beds, the marine deposits of the Jurassic are prominent, and all, together with the red Triassic, lying conformably upon the carboniferous.

The stratigraphy is most characteristically shown at Como in Southern Wyoming. The summit of an anticlinal ridge has here been excavated, and a basin formed for an alkaline lake. A steeply inclined ridge of several miles in length is prominent immediately south of the lake with the fossiliferous strata largely exposed. The fossil outcrops here extend from near the summit of harder sandstone, which has not yet produced any cretaceous fossil leaves, down to near

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the marine beds containing an abundance of characteristic Jurassic invertebrates. The bluish clayey shales here preponderate, but are variously interspersed with admixtures of clay and sand, soft and hard sandstones, in all of which fossils are found, in some cases even large bones being imbedded, partly in sandstone, partly in shale. Invertebrate fossils are extremely rare. Of the vertebrates the individuals most numerously represented are the tortoises, (*Compsemys*) with not infrequent teeth of *Ceratodus*, and vertebræ probably of the same. Of isolated teeth, those most frequently met with pertain to the crocodiles and carnivorous dinosaurs. Isolated bones of single individuals of the larger species are occasionally found, but not in a single instance do I know of numerous bones, pertaining to one skeleton of such species, being found unmixed with other remains. By far the most commonly, extensive deposits, or "quarries," are found containing remains of numerous individuals mingled together in the most inextricable confusion, and in every conceivable position, with connected limb bones standing nearly upright, connected vertebræ describing vertical curves, etc., precisely as though in some ancient mud holes these huge monsters had become mired and died, and succeeding generations had trodden their bones down, and then left their own to mingle with them. Such extreme confusion is however only seen in the clay deposits containing fewer waterworn fragments and small animals.

In sandstone deposits the large bones, though variously intermingled, are generally lying more nearly horizontal, with abundant waterworn fragments, and numerous remains of turtles, crocodiles, fishes, and small saurians.

These beds have hitherto been classified as the lower or Dakota group of the cretaceous, and still are by Prof. Cope. That no marked line will be found separating these estuary deposits from the Dakota, as defined by the distinguished paleontologist, Prof. Lesquereux, is possible, but until better evidence is obtained among the invertebrates to unite them, it will be far more reasonable to accept the evidence of the vertebrates, and assign to them, as Prof. Marsh has done, an equivalency with the European Wealden or Upper Jurassic.

So far, in addition to the dinosaurs, one species each, of fish, tortoise, crocodile, (*Diplosaurus* Msh.) pterodactyl, (*P. montanus* Msh.) and mammal (*Dryolestes priscus* Msh.) have been described from this formation. Of the dinosauria, so far thirteen genera have been characterized by Profs. Marsh and Cope, as follows: *Titanosaurus* Msh, (Atlantaurus Msh), *Stegosaurus*, Msh, *Nanosaurus* Msh, *Camerasaurus* Cope; *Apatosaurus* Msh, *Allosaurus* Msh, *Caulodon* Cope, *Tichosteus* Cope, *Amphicoelias* Cope, *Morosaurus* Msh, *Creosaurus* Msh, *Laosaurus* Msh, and *Diplodocus*, Msh, and of which probably one-half are synonyms. *Titanosaurus* and *Camerasaurus* are without much doubt synonymous, and the latter is considered by Prof. Owen identical with his *Chondrosteosaurus*, which is, however, only known from two imperfect vertebræ from the English Wealden. The same evidence would however include *Apatosaurus* and *Morosaurus*, but among these there are certainly two valid genera, as proved by the structure of the pelvic girdle, and hence, till the original type of *Chondrosteosaurus* is better known, it will be premature to unite the American species with it. According to the rules of Zoological nomenclature, no genus is entitled to acceptance, unless it is distinctively characterized. But so long as it is the custom to define genera from single bones, or uncharacteristic parts of the skeleton, such a rule has its objections. If, as in the present case, several genera, which can not be individually separated from the original imperfect type, are successively eliminated, the last must assume the type name; but this original genus may be found, when better known, to be distinct from any of them, or perhaps identical with some other one previously eliminated. Or, perhaps

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imperfect specimens may be found that can not be generically separated from others in remote formations, and where to unite them would be doing violence to our preconceived opinions of the persistence of geological types. But, on the other hand, the indiscriminate application of names to genera, that can neither be positively united with, or separated from, previous ones, is pernicious.

The group of saurians represented by these four or five genera, including also *Amphicoelias* and *Diplodocus*, together with *Ceteosaurus*, Owen and other European ones, have been characterized by Marsh under the name *Sauropoda*, which, together with Huxley's *Ornithoscelida*, or true dinosaurs, have been made suborders of *Dinosauria*. They are intermediate between the crocodilia and true dinosaurs. They were the largest of terrestial animals, herbivorous, probably amphibious, and awkward and slow in their movements. The head, and especially the brain, was very small, the neck long, the dorsal vertebræ massive in their proportions, but cavernous and pneumatic, so interlocked as to give great strength and but little breeding. The sacrum of several vertebræ, solidly united, and the tail heavy and long. They walked upright upon all four nearly equal massive legs; the feet with five short toes. The largest of these described by Prof. Marsh could not have been less than eighty feet in length and twenty feet in height, and, probably, thirty tons or more in weight. Although of such almost incredibly gigantic proportions, they were doubtlessly inoffensive and harmless in their nature, relying neither upon agility or defensive weapons for protection, but rather upon size alone.

Stegosaurus was described by Marsh as a separate order, but it is possibly allied to the Sauroscelida. It was a large reptile with a heavy dermal osseous plates or exoskeleton.

The Ornithoscelida are represented by *Nanosaurus*, *Laosaurus*, *Allosaurus*, *Creosaurus*, and a species referred to the Cretaceous genus *Drytosaurus* (Laelaps) by Cope, and indicate three well marked families.

Nanosaurus was the smallest, and together with *Compsognathus*, from the European Wealden, to which it is probably allied, the most ornithic of known reptiles. They were animals scarcely larger than a cat, with short thighs, and long, slender legs, the limb bones being extremely hollow and pneumatic, as in most birds. They doubtlessly walked erect upon the two hind limbs, with very short and weak fore limbs, and were quick and agile in all their habits.

Laosaurus was a genus of dinosaurs very closely allied, perhaps identical, with *Iguanodon* and *Hypsilophodon* of the European Jurassic. They were herbivorous animals, which, in the largest known species, measured perhaps ten feet in length, or, when standing erect upon their hind legs, which they must have habitually used, were about five feet high. The head was of moderate size and the teeth serrated upon the edges; the neck was short, not at all slender; the shoulders small, and the fore legs not more than half as long as the hind ones. The pelvis showed a singular mingling of the bird and rep ile types. The pubes and ischia, if united in symphyses at the ends very feebly so, and probably not at all. The pubes had two rami or branches, the anterior one, the homologue of the lizard or crocodile pubis, a slender spatulate bone, with free ends; the posterior branch or bird pubis, long, slender rod-like bones, extending back parallel to the ischia, in a manner particularly like the struthious birds. The thigh and leg bones were of nearly equal length, rather slender and hollow; the tarsus very similar to that in the bird, the foot slender and three-toed. The tail was probably rather long and compressed from side to side. Other species were smaller, of less than half the size of the larger ones. They were less bird-like than the preceding, but more so than the following.

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Allosaurus and *Creosaurus*, which are possibly synonymous, together with *Dryptosaurus trihedridon*, comprising probably not more than two or three species, without much doubt included, together with *Megalosaurus* and *Poikelopleuron* of the European Wealden, to which they are strongly allied, the most carnivorous and rapacious of terrestrial reptiles known. The teeth are long and sabre-like, recurved and minutely serrated, and the jaws were doubtless furnished with strong masseter muscles. The fore limbs were, in all, much smaller than the hinder; the neck was short, the tail probably slender, and very effective as a weapon. The pelvis is very imperfectly known in all the carnivorous genera, but was undoubtedly very narrow, as shown by the sacrum. The astragalus was very bird-like, with a high ascending process; the feet three-toed. The claws were extremely slender, curved, and pointed. The bones were all very hollow, light, and of dense osseous texture. *Creosaurus* is estimated at thirty feet in length. They probably habitually walked upon the hind feet, progressing rather by leaping than by strides.

Caulodon and *Tichosteus* are very imperfectly known from teeth and fragmentary vertebræ.

That not only in species, but also in individuals, this age was very prolific, seems probable from their abundant widely scattered remains, and moreover, localities but a few hundred miles apart, seem to differ much in their species. Not a single species has been found identical in any of the three localities mentioned above, although there possibly may be upon further study. Upon many obscure problems of the ancient Mezozoic life, much light may be confidently expected from the vast unexplored deposits of the Rocky Mountain Jura.

CRETACEOUS FORESTS AND THEIR MIGRATIONS.

By Prof. B. F. MUDGE, Manhattan.

One of the most interesting problems of geology, is the study of the geographical distribution of animal and vegetable life over the globe, in the different geological ages, and more particularly the migrations from one portion of the earth to another, consequent on the sinking of one area beneath the ocean, and the rise of another. Such changes of land have been exceedingly slow, and consequently the migrations of animal and vegetable life have been equally so.

Prof. Asa Gray has recently, in the *American Journal of Science*, given us a very interesting essay on the origin by migration of our present forests of America and Europe. He describes the close relationship of the living forests, and those fossilized in Greenland in the Miocene deposits. From a series of facts, he comes to the conclusion that the flora of both continents have descended from the common stock which lived in Greenland during the Miocene epoch. He stops there and goes no further back. He does not inquire from whence came the Greenland forests.

Now by the labors of Heer and others, we have a knowledge in detail of the Greenland flora, not only in the Miocene, but in the Upper Cretaceous. They show a near resemblance to the vegetable life of our Dakota group. As the latter is much older than the former, we now propose to give our reasons for believing

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that the Dakota epoch of Kansas, Nebraska, and some portions of the Rocky Mountain region, was the true and original nativity of the latter forests now fossilized in the deposits of Greenland.

To do this, the facts will be a little clearer if we show, by the labors of Prof. Lesquereux, the close resemblance of the Dakota forests, and those now living in the temperate portion of the United States. In his "Cretaceous Flora," and other publications, Prof. Lesquereux has given us a careful description of 164 species mostly of forest trees. Of these about three-fourths are dicotyledons, or representations of our forest and fruit trees of the temperate zone, excepting the evergreens. They are distributed among nineteen orders and fifty-two genera. They embrace the Oak, Willow, Poplar, Magnolia, Sassafras, Buttonwood, Tulip tree, and also *Pyrus* and *Prunus*, to which our best fruit trees belong; and in addition a few semi-tropical forms, like the Fig, which now grows wild in Florida. Of Prof. Lesquereux's list of fossil plants from the Dakota, fifty-six per cent. of the genera are identical with those now living east of the Rocky Mountains, in the temperate zone of the United States. To this must be added twenty-four per cent. which are apparently identical, represented by Populites, Betulites, Acerites, Negundoides, Laurophyllum, etc. Of the remaining twenty per cent., a few, like the Fig and Cinnamon, are now living in the tropics, while a few genera have become extinct.

When we examine the species under these genera, we find some exactly identical with those now living, and many others apparently so. *Sassafras officinale*, now the only species growing in the United States, was first discovered in the Dakota, by the writer, and named by Prof. Lesquereux, *S. Mudgii*, but on careful examination by him and Prof. O. Heer, the identity of the Dakota and living species is well settled. This species, and apparently other species, have been found in Greenland, and one closely allied to it in Europe. *Fagus polyclada*, of our Dakota, "is an exact representative of the only species of beach in America." *Persea Sternbergii* from the same deposits compares closely with *P. gratissima* of Cuba and Brazil. Others, like *Cinnamomum Scheuchzeri*, though not coming down to the present time, hold their specific characters, from the early Cretaceous of America to the Miocene of Europe.

The Conifers show even a stronger persistence in retaining their characteristics. Saporta and Marion, in their Flora of Gelinden, speaking of *Pinus Quenstedti*, which is found in our Dakota and in the Upper Cretaceous of Greenland, say, "This species does not differ in character from the living Mexican species with quinate leaves." *Sequoia gigantea*, our big redwood of California, is recognized as the *S. Sternbergii* of the Miocene, found at Disco. So *Sequoia fastigiata* in the deposits of Kansas, Moletin and the Greenland upper Cretaceous, is considered by Lesquereux very nearly the same as *S. condita*, fossil, and the living *S. gigantea* and *S. sempervirens*.

Prof. Gray expresses his idea of the close resemblance in the following terms: The twigs of the Sequoia in the Eocene, are "so very like *S. gigantea* of the Sierra Nevada, that if such fossil twigs, with leaves and cones, had been dug up in California, instead of Europe, it would confidently be affirmed that we had resurrected the veritable ancestors of our giant trees."

The Bald Cypress, now our only living species, has a close ally in the fossil *Glyptostrobus*; "a sort of modified *Taxodium*, about as much alike as one species of redwood is like another."

As the Conifers are a very old family, coming down from the close of the Silurian Age, this resemblance and persistence of features does not impress so strongly.

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But it must be borne in mind, that neither *Sequoia* nor *Taxodium* have been found in any part of the globe in formations older than our Cretaceous.

The flora of the Dakota is more nearly allied to our living trees than to the forests of Europe. That quarter of the globe has no Magnolia, Liriodendron, Liquidamber, Sassafras, Coffee tree (*Gymnocladus*) or Walnut, yet all are found living with us, as well as largely represented in our Dakota fossils. Europe has no Catalpa, but we have the fossil *Protophyllum*, which appears to be nearly the same.

It is also a fact of much interest to note that the proportion of apetalous and polypetalous plants, of imperfect and perfect flowers, in Prof. Lesquereux's list, is very nearly the same in the Dakota group as in our living flora.

According to our present geological knowledge, the American lower cretaceous contains the first and oldest Dicotyledons. Future discoveries may give us a still further antiquity to our forests. But as the early Cretaceous flora has been known for many years, and carefully studied without finding anything of the same type in any of the older formations, it is very probable that we must date the origin of the Dicotyledonous plants with the dawn of the Cretaceous age.

At the close of the Dakota epoch we know that a long period elapsed, extending to the close of the Cretaceous, during which all portions of the United States from the Atlantic to the Pacific, excepting a few islands, and probably the southern part of British America, was under the ocean. It was the reign of the large fishes, saurians, etc., found fossilized in Western Kansas, Nebraska and Wyoming. During this time the forests became locally extinct. But their representatives are found in the northern regions in the Upper Cretaceous, over extensive areas, that betoken a continent, or at least continental islands. The leaves and other remains of the forests occur in Alaska, near McKenzie river, North Somerset and Greenland ; and undoubtedly at intermediate points.

These facts, and the strong resemblance between the floras of the Dakota period and those of Alaska, McKenzie and Greenland, together with their common alliance to our living forests, justify us in concluding that the vegetation of our lowest Cretaceous slowly migrated ; and, the climate in the northern regions then being like that of Virginia and the Carolinas at the present day, it overspread a large extent of the northern regions, far within the Arctic Circle. When in the Tertiary times, the sunken continent arose again, the flora returned to its former home. As the Rocky mountains arose in the Eocene it came back by the way of that backbone of the continent, and thence spread over the whole of the temperate zone of North America. Those with a preference for mild winters inclined to the western slopes, and others took their way toward the East, as Prof. Gray has narrated. Many small shrubs, protected by the large trees, went and came with them.

When we consider the long periods covered by the Cretaceous and Tertiary ages, the rate of migration may have been exceedingly slow. If we allow a century for a life generation of each forest, the seed of the trees need not have been carried more than a single mile in a single generation. Thus slow but sure is the plan of nature's operations.

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INTERNAL HEAT OF THE EARTH.

By Prof. B. F. MUDGE.

We frequently notice, in newspapers and popular treatises on geology, the theory stated, in the most deliberate manner, as if it were accepted by all scientific men, that heat rapidly and regularly increases from the surface to the center of the earth. They tell us that at the depth of twenty or thirty miles, and from thence to the center, the whole mass of the globe is in a fluid, molten state, having an intensity of heat which even the imagination of the chemist can hardly comprehend. This theory is based on the hypothesis that, starting from the surface, there is a constant and uniform increase of heat, at the rate of one degree F. for every forty-five feet in depth. This would give a temperature of 212°, or that of boiling water, at little more than a mile. As iron melts at 3,000°, that temperature would be reached at twenty-five miles. At a depth of about fifty miles a heat would be found, sufficient to melt the most infusible rocks. Most of our strata, like limestone, would yield at a less heat. At the center of the earth, by the popular ratio, it would be 600,000°, or eighty-five times greater than that required to melt any combination of natural elements (except platinum) found in the earth's crust. Some observations make an increase of heat equal to one degree for every thirty-two feet. This would place the molten ocean nearer the surface of the earth, the crust thinner, and the heat at the center more intense.

This theory was advanced by some of the early writers, on a limited array of facts, and a narrow comprehension of nature's laws. We know of no geologist of high standing at the present day who sustains this theory.

The first and great objection to this hypothesis lies in its opposition to well-known chemical laws. Every chemist who fuses metals in the laboratory, and every furnace-man in our iron, zinc or copper foundries, knows that when he has raised his crucible, or furnace, to the melting point of any metal, he can by adding fuel raise the molten material to far higher degrees of heat, but if he throws in pieces of the unmelted metal the temperature will not rise beyond the melting point, till the last ounce has become liquid. Thus, lead will melt at 625°, but after melting, its temperature can be raised hundreds of degrees till it boils, or even becomes vapor. But if when the lead has just reached the melting point, bars of lead, or even shot, are added to the liquid surface of the furnace, the temperature will be constant at 625°. This rule applies to all known substances. It is often seen in the familiar example of water. So long as a fragment of ice remains in our kettles, no fire will raise the temperature of that fluid above 32°. Apply this simple chemical test, and it at once settles this question, that the interior of the earth, if liquid, can not be above the melting point (7,000°) of the most refractory portions of the earth's crust. If the heat of the interior exceeded that point, this thin crust, whether of twenty-five or one hundred miles, would be immediately melted into the common mass, and we should not be here to-day to discuss its plausibility.

Still, it remains to consider how far we have any data to fix the rate of increase of heat, and at what depth the crust of the earth may be in a melted state. Let us look at the facts on which the theory of a regular and uniform increase of heat downward, is based.

Prof. Wm. B. Rogers, on examination of the coal mines of Eastern Virginia, computed the increase at one degree for every sixty feet. In the United Copper

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Mines of Cornwall, 1,201 feet deep, the increase is about half as much, or thirty-one feet to a degree of heat. At the coal mine at Ravin, France, 597 feet deep, the increase is one degree for every fifty-five feet. At another coal mine in the same country, at Castellan, 630 feet deep, one degree to forty-one feet. At another at Littry, 325 feet in depth, one degree for thirty-six feet. At a coal mine at Wigan, Lancashire, England, 750 feet deep, one degree for each forty-eight feet, but far from a uniform rate of increase at various depths. At the coal mine near Sunderland, England, 1,584 feet deep (going 1,500 feet deeper than the sea level), the increase is one degree in sixty feet. At the Dolcoath mine, Cornwall, 1,381 feet deep, one degree for every fifty-four feet. But the mine at Bechertgluck, Saxony, calls for particular attention. The whole depth is 1,246 feet. For the first 236 feet from the surface the increase of heat is at the rate of one degree for every 175 feet. For the next 316 feet, one degree for each sixty-four feet. For the next forty feet, about one-third of a degree. Then for 289 feet, one degree for each sixty-seven feet, and for the remaining 366 feet, one degree for sixty-five feet. Thus we have five different rates of increase in one mine, the extremes being one degree for 175 feet, and sixty-four feet, or a variance of 275 per cent. This shows that in this mine—a very deep one—there is no systematic rule for the increase of heat with the depth. It will be noticed, also, that the extremes of variation are included in a depth of 552 feet. As this is a variation caused by local influences, may not the heat in other mines be also owing, in a greater or less degree, to local causes? The lead and silver mine of Kurpinz, in the same country, shows a similar example of variation. The mine is 1,063 feet deep. For the first 413 feet the increase is one degree for each thirty-one feet. For the next 273 feet it is at the rate of one degree for each forty-three feet; and from thence to the bottom of the mine, 377 feet, at the rate of one degree for fifty feet. Here is a variance of sixty-one per cent. An increasing ratio, but not a uniform one. In the immediate vicinity is another mine, Junghoke, where the increase is one degree to 102 feet.

Springs in mines, and more particularly artesian borings, which have been carried to great depths, have been quoted to show the same law of increase. The results of the observations are far more variable.

In a spring in the mine of Kurpinz, 634 feet deep, the increase is one degree for each nineteen feet. At Westphalia, in a well 2,200 feet deep, the increase is one degree for fifty feet. At Yakutz, Siberia, in a well 407 feet deep, Magnus found a gain of one degree for each twenty-seven feet. Other places in Siberia show that the increase varies from thirty to as low as fourteen feet to each degree.

The springs in the lead mines at Paullanen, Britany, show an increase varying from eighty-two feet to 351 feet, to one degree of heat.

At an artesian well near Berlin, 675 feet deep, there are three degrees of ratios of increase, being one degree for twenty-eight, thirty-five and thirty-six feet, respectively. In America the artesian wells are equally at variance with any settled law of increase. At New Brunswick, N. J., at a well 394 feet deep, there is an increase of a degree for every seventy-two feet. At Charleston, S. C., 910 feet in depth, a well gives one degree to each sixty-four feet. At Connelsville, Ohio, 400 feet deep, a boring gave one degree to 120 feet. Another at the same town, 819 feet deep, gave *no increase*. A well also, near Chicago, about 1,200 feet, showed "no appreciable increase of heat."

The Artesian well in the State House yard, at Columbus, Ohio, 2,575 feet deep, gave a degree for every seventy-one feet. At Louisville, Ky., a well 2,086 feet deep gave a degree to seventy-four feet. The well at St. Louis, Mo., the deepest in America, 3,843 feet, is the most remarkable. At 3,029 feet it showed a nearly uni-

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form increase of fifty-seven feet to a degree, but for the remaining 814 feet it *decreased* two degrees, or a loss of a degree for each 407 feet.

If this rule of a regular increase of heat were a reliable one, we might expect that the waters of the ocean would show a large increase of heat as we penetrate its depths. But no such result has been discovered. On the contrary, all our deep sea soundings show a state of temperature adverse to this theory. According to nearly all the facts in our possession, instead of a theoretical rate of increase, there is a steady and somewhat uniform decrease, so that the bottoms of the great oceans are near the freezing point of fresh water. The soundings on the Telegraph Plateau, in the North Atlantic, sustain this, as the water was usually, at the bottom, below 40°. Off the coast of Norway, lat. 76° 17′, long. 13° 53′ E., the temperature at the bottom, 9,000 feet deep, was 32° and 33°, while the surface was 41°. The numerous soundings, both in the Atlantic and Indian oceans, by the Challenger, show that all the deep portions of these oceans were of a uniform cold temperature, much below that of the surface. But the rocks underlying the great oceans, twenty and thirty thousand feet, are so much nearer the hot regions of the earth, that they should, if the popular theory is true, be far above the average temperature of the surface, if not to a high, almost boiling degree.

That the interior of the earth has a higher temperature than the surface appears to be certain, but that a moderately high percentage of it is in a molten state is not sustained by science. The examples we have given, and many more of a similar character might be added, show that there is no regular rule which will give us even an approximate knowledge of the heat of the center of our globe.

Some very valuable scientific investigations were made many years ago, by Prof. Hopkins, of London, in relation to this question. His conclusion was, that the crust of the earth was not less than eight hundred miles in thickness, and that the fluid portions of the interior, were little, if any, above the melting point of refractory rocks.

Sir Charles Lyell, in Principles of Geology, says of the theory of the intense increase of heat toward the interior of the earth, "It seems wholly inconsistent with the laws which regulate the circulation of heat through fluid bodies." The fluid portions under volcanos must, therefore, be regarded as exceptional and local.

Prof. J. Le Conte, in his recent work, says, we must base our geology on substantially a solid globe. Prof. J. D. Dana, in his last edition of the Elements of Geology, takes about the same conclusion.

KANSAS MOUNDS.

By F. G. ADAMS, Topeka.

The first recorded mention of ancient mounds in Kansas, was made of mounds near Fort Leavenworth, by Rev. Isaac McCoy, in his account of the survey made by him, of the boundary lines of the Delaware Indian reservation in 1830. This Mr. McCoy was one of the first to bring forward the project of transferring to Kansas, from the East, the Indians of the various emigrant tribes which the settlers of Kansas found here twenty-three years ago, occupying large portions of what is now the most populous part of this State, but who have since that time nearly all

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been removed to the present Indian Territory. Mr. McCoy was a missionary on the Wabash and St. Joseph rivers, in Indiana and Michigan, as early as the year 1817. Experience had taught him that contact with frontier white men, gathering in around his missionary stations, resulted in undoing the work of education and civilization which he and his associates had for a time accomplished with the Indians. He became impressed with the opinion that their removal to a remote territory would enable the missionary work to have the full effect of christianizing and civilizing the Indians. He personally presented his views to Secretary, John C. Calhoun, and to Presidents Monroe and John Quincy Adams, all of whom approved the scheme, and commended it to the action of Congress. After its adoption, Mr. McCoy was made the agent of the Government, in the assignment of reservations to the several tribes. In the performance of all that work; first of securing the adoption of his scheme of the policy of the Government, and then of personally effecting the removal and establishing his missionary stations among the Indians, Mr. McCoy displayed the character of a true Christian hero, the like of whom, it seems to me, we have scarcely had upon Kansas soil since his time. The simple narrative of his labors, and of those of his co-laborers, David Lykins, Jotham Meeker, and Robert Simmerwell, as contained in the volume entitled "The History of Baptist Indian Missions," published in 1840, presents examples of wonderful Christian zeal. Considering that the work done by these men related to efforts for the civilization of people of the American aboriginal race, and that the work pertained to Kansas, an appropriate subject of investigation is here suggested in the anthropological department of this Academy.

Mr. McCoy made the survey of the Delaware reservation, in the months of October and November, 1830. The flag-staff at Fort Leavenworth was made the initial point of the northern boundary line. The Fort was then merely a military cantonment which had been established five years before. The line was made to take a direction west by north for a distance, so as to give the Delawares an outlet to the buffalo plains, shunning the then Kaw reservation, afterwards the Pottawatomie reservation. Thence the line was extended due westward, till it reached a distance of 200 miles from the Missouri river. During the prosecution of this survey Mr. Mc Coy's party encountered two of those sand and charcoal storms, not uncommon in the early days of Kansas, but now never occurring in the older portions of the State, in which the air became so filled with dust and the remains of recently burnt prairie grass that almost the darkness of night came on at midday. He saw and described the Great Spirit Spring, and tells us that the name Wa-kon-da is a term of the Kansas Indian tribe, meaning Great Spirit Spring. He examined the salines of the Solomon and Saline river country, and otherwise made his survey one of much value in a scientific point of view.

This historical explanation has been made because the facts mentioned have a scientific bearing; and they may not be known to all, as the book in which they have been found has long been out of print.

In respect to the Fort Leavenworth mounds, Mr. McCoy says:

"The ancient artificial mounds and fortifications, so common in the Western States, are seen less frequently as we go west from the Mississippi river, and they disappear in the prairie country original to the Indians. About a mile west of Fort Leavenworth, on a hill which commands a fine prospect in every direction, we discovered eight mounds near to each other, which from their relative position and their structure, attracted our particular attention. They were about twenty-five feet in diameter at base, six of them nearly in a direct line, about thirty feet asunder, and the other two were on each side of the line opposite to each other near the

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center. They were composed of stones and earth ; the former placed in a circle. One of these mounds we excavated, and in the hollow within the circle of stones we found a few human bones, some of which had belonged to adults, and others to children. Excepting the pieces of the skulls, they were so much decayed that, with the assistance of Dr. Rice McCoy, and Dr. Bryant, surgeon of Fort Leavenworth, it was not easy to discover to what part of the human body they belonged. They had been under the action of fire, and were mixed with charcoal, burnt earth, and stones that had been heated with fire. It appeared that after the bodies had been subjected to the action of fire, without being consumed entirely, they were covered with earth.

"Some Indians on the Columbia river burn their dead ; but whether they leave any portion of the bones in the place of burning, I have not been informed. The place where these mounds were erected, and their internal appearance, favored the conjecture that human sacrifices had there been offered."

As regards the recent examinations of the mounds, they have been only partial, but have been sufficiently prosecuted to demonstrate the correctness of Mr. McCoy's observations, and to warrant the belief that the mounds belong to the works of the true mound builders of North America.

In June last, in company with Mr. Henry Kuhn, of Leavenworth City, I visited the location. We drove from the Fort, up to, and along the beautiful road-way, known as the "Sheridan Drive," which passes along on the top of that extension of the Pilot Knob ridge which circles along the west line of the Military Reservation, about one mile westward of the Fort. We found six mounds near this road, one on the west side of the road and five on the east side. At a more recent visit, made in company with Dr. R. J. Brown, of this Academy, Dr. B. E. Fryer, of Fort Leavenworth, Mr. R. N. Hershfield, and others, a seventh mound was seen ; perhaps a quarter of a mile remote from the first six mentioned. The latter are in an irregular line, generally about forty feet apart. They are about twenty-five feet across at the base, and are quite flattened, none being more than four or five feet in height. These mounds as seen do not exactly correspond in number and position with those described by Mr. McCoy, and other observations will be necessary in order to identify the particular mounds.

At the visit in June, an excavation was made into one of the mounds. The excavation was commenced at about the center of the top, and an oblong opening made towards the circumference, about two and one-half feet in width, and four and one-half feet in length, and extending to the bottom, about four feet. Stones projected from the top of the mound, and stones of all sizes were closely intermingled with earth to the depth of about two feet, causing much labor with pick to proceed to that depth with the digging. After that, soft earth, easily thrown out with the spade, was found, to near the bottom, when some more stones were found. These had marks of fire, as did also the earth in some places near the bottom. Fragments of bones were found intermingled with the stones and earth near the bottom. The fragments are here exhibited. Some of them appear to be somewhat charred. Some pieces of skull are evidently human remains. The others may be. But here is a fragment of deer horn, apparently partially charred. One tooth thrown from this mound, now in the possession of Dr. Fryer, was identified by him as a human tooth.

At the more recent visit spoken of, another of the mounds was opened in part. This mound exhibited at the top an elliptical boundary line of projecting points of stones ; the ellipse measuring twelve feet by nine feet in its axis. No stones appeared at the surface, except in the curved bounds of this ellipse. The excavation

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was made through one end of this ellipse, and an irregularly laid stone wall was found extending from the top of the mound to the bottom at this place. The partial excavation made indicated that such a wall followed the elliptical line of projecting stones around the mound, inclosing a mass of earth within. Near the bottom at the place opened was found, extending inward from the wall towards the center of the mound, a vault-like opening. This, however, may have resulted accidentally by reason of the immethodical manner in which the wall was laid up. No human remains or other relics were found in making this imperfect examination of this mound.

It was hoped that opportunity would admit of a more thorough examination of the Fort Leavenworth mounds. Yet, while what has been done affords materials for but little addition to the contributions of scientific knowledge brought in at the meetings of this Academy, what is here presented may prove of service, as leading to investigations yet to be made in the direction of determining to what extent the works of the mound builders exist in Kansas. These mounds are, it is believed, the only ones yet seen in Kansas, of which any record has been made.

ON THE DERMAL COVERING OF A MOSASAUROID REPTILE.

(*Liodon dyspelor* Cope.)

By Prof. F. H. SNOW, of the University of Kansas.

The geological section of the Kansas University scientific expedition for 1878, in charge of Prof. B. F. Mudge and the writer, examined with care a portion of the blue-gray shales and the yellow limestones along the Hackberry creek, in Gove county, Kansas. These rocks belong to the Niobrara group of the cretaceous formation. The locality had been previously visited by several parties of geological explorers, who had obtained from it many valuable fossils, and it was hardly expected that the gleanings from a field so thoroughly worked would contain anything of unusual value. But the frosts and rains of a single year had exposed to view many remains of fishes and saurians, and our labors were unexpectedly and abundantly rewarded. In less than three weeks, 41 saurians, 117 fishes, and 6 pterodactyls (Pteranodonts) were discovered, many of them in almost perfect condition, and all of them of sufficient value to justify their transportation for a distance of 300 miles, to take their places in the cabinets of the University.

The most valuable specimen was a saurian, found in the yellow limestone, by the writer. A single vertebral bone was first observed, on June 17th, upon the blue shale at the bottom of a narrow ravine. No further remains were discovered until the following day, when a systematic search was made, in company with my assistant, Mr. L. L. Dyche. We soon detected a second bone, this time one of the phalanges, lying loosely upon the side of the ravine, several feet above the first bone, and a little farther up the ravine. In a few moments more the head of a ver-

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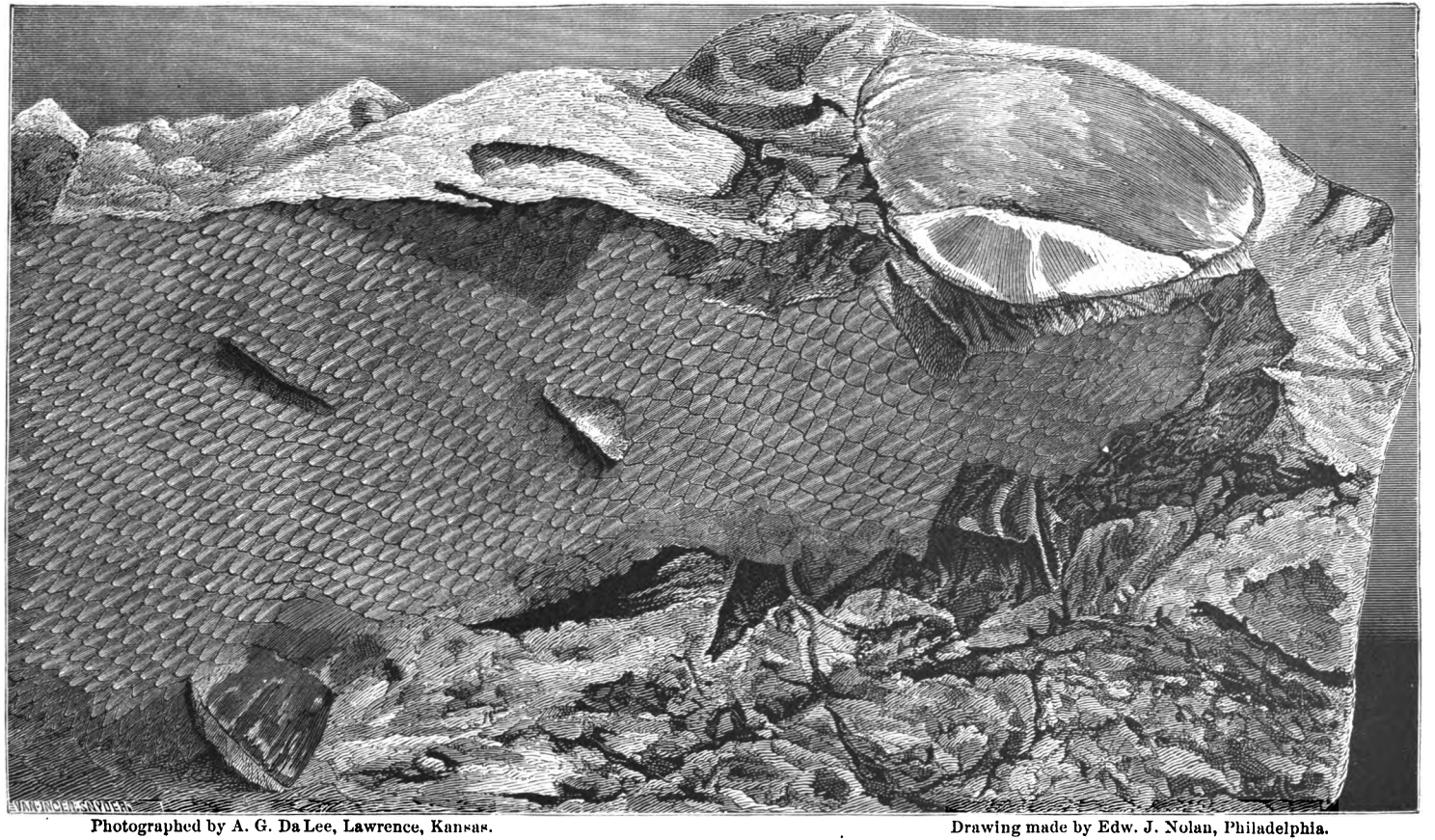

Photographed by A. G. Da Lee, Lawrence, Kansas. Drawing made by Edw. J. Nolan, Philadelphia.

DERMAL SCALES OF *LIODON* OWEN (*TYLOSAURUS* MSH.)

(NATURAL SIZE.)

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tebra was obscurely seen in the face of the solid limestone, about eight feet from the top of the ravine. An hour's work served to detach a block of rock containing several vertebræ and other bones. While removing the superfluous material from this block, in order to facilitate its removal to camp, a fortunate stroke of the hatchet revealed a peculiar reticulated surface, several square inches in extent. The thought instantly flashed upon my mind that here was something which had never before been seen by human eye. The conclusion was irresistible that the reticulated surface was the fossilized covering of the skin of the saurian, so perfectly preserved that every scale was distinctly visible, its outline clearly marked, and the elevated central line, or "carina," unmistakably indicated. Although, according to Prof. Dana's time-ratios, a period of five million years must have elapsed since this saurian swam in the shallow waters of the cretaceous seas of Western Kansas, yet each individual scale exposed to view was as perfectly preserved as if the animal had but yesterday died.

Prof. Marsh, of Yale College, some years ago described the large dermal plates, or scutes, belonging to other mosasauroid genera, which, as he writes me, "appear to be mainly confined to the neck and throat." But, so far as I am able to learn, nothing has been hitherto known of the *general* covering of the saurian body in *any* genus, and nothing whatever of the dermal covering in the genus *Liodon*. It might have been expected that this covering would be found to consist of larger plates, like those of the alligator and crocodile. On the contrary, it is composed of small scales, much resembling in size, shape and arrangement, the scales of living Ophidians. Dana, in his Manual of Geology (2d Edition, p. 465), speaks of the mosasaurs as "snake-like reptiles." This comparison is strengthened when it is found that their dermal scales were almost an exact pre-figuration of those of the rattlesnakes which infest the ledges within which these saurians are found. The scales first exposed to view appeared to be on the anterior portion of the ventral surface of the body, but another small area was found not far from the pelvic bones. All the scales discovered were on the lower surface of the body, the bones lying above them except in one or two spots where a bone had, by pressure, been forced through the dermal covering. The original surface exposed was afterwards increased in extent, until a total continuous area of thirty-three and one-third square inches was uncovered. This surface contains an average of ninety scales to the square inch, or a total of 3,000 scales. These are all preserved upon a single block of limestone, which also contains several vertebræ, phalanges, and other bones. A comparison with the scales of the living rattlesnake of the plains (*Crotalus confluentus* Say), indicates that the scales of the saurian were somewhat smaller than those of the snake, which, in a full-grown "rattler," average eighty to the square inch, instead of ninety.

On the day after the discovery of this dermal surface, I determined to obtain the remainder of the saurian, which was imbedded in the solid rock. It was necessary to remove eight feet of superincumbent material before the proper level or "horizon" was reached, and also to undermine the specimen, in order to secure the remains in their original position, and, if possible, to expose a larger portion of the dermal covering. After three days and a half of hard labor, by myself and two assistants, we succeeded in removing one large slab, five and one-half feet, by two and one-half feet, and six inches in thickness, weighing 500 lbs., and two smaller slabs, each containing the bones of a hind leg and foot. The large slab was found to contain dorsal vertebræ, ribs, and pelvic bones, in perfect preservation and apparently without distortion. It also contains one of the forward limbs, or hands, lying un-

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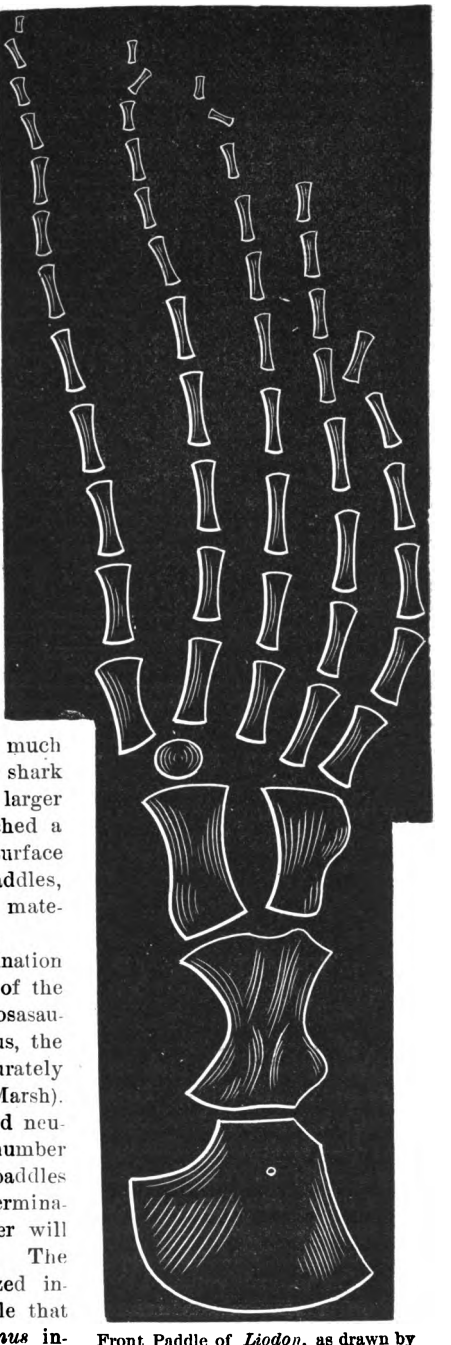
derneath the ribs and vertebræ, with the bones in natural position. In this hand there are forty-seven of the hour-glass-shaped bones of the palm and fingers, the five series consisting respectively of twelve, eleven, ten, eight, and six bones. The terminal or twelfth bone of the first series is very minute, and triangular in shape, or, more exactly, shaped like the half of an hour-glass.

No attempt has yet been made to expose the dermal covering contained in the large slab, and it is exceedingly doubtful if such an attempt would prove successful. The bones imbedded in this slab, and now brought out in relief, are not in their natural position, except those of the hand above mentioned. Only two of the twenty vertebræ, which are scattered over the slab in all positions, remain united. The dozen ribs are variously disposed, and one of the thigh bones occupies a spot not far from the center of the lower margin of the slab. The appearance is very much as if some more powerful saurian or shark had devoured the flesh upon the larger bones of the victim, leaving untouched a portion of the skin of the lower surface of the body, and one of the front paddles, which probably did not contain much material for the gratification of his appetite.

In regard to the generic determination of this saurian, I can only say, that of the three well marked genera of the mosasauroid reptiles of the Kansas cretaceous, the specimen seems to agree most accurately with *Liodon* Owen (*Tylosaurus* Marsh). This genus is indicated by the broad neural spines, and by the fact that the number of bones in the first digit of the paddles is the greatest. The specific determination given in the title of this paper will probably be found to be correct. The specimen appears to be a small-sized individual of its species. It is possible that the species may prove to be *micromus* instead of *dyspelor*.



Front Paddle of *Liodon*, as drawn by W. H. Simpson.

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The following measurements are appended:

	M.
Dermal scale—	
Length	.0033
Breadth	.0025
Length of "carina"	.0037
Dorsal vertebra—	
Length of centrum	.075
" " neural spine	.095
Breadth of neural spine, at base	.074
" " " " tip	.039
Vertical diameter of cup	.058
Transverse diameter of cup	.071
Longest rib—	
Tip to tip	.381
Along curvature	.418
Breadth at base	.025
" " tip	.009
" " center	.012
Femur—	
Length	.132
Breadth at proximal end	.062
" " distal end	.073
" " center	.050
Front paddle—total length	.726
Coracoid—	
Length	.118
Breadth at proximal end	.131
Curvature at proximal end	.195
Breadth at distal end	.056
Distance of perforation from outer edge	.026
" " " " inner edge	.042
Humerus—	
Length	.122
Breadth, at proximal end	.074
" " distal end	.080
Ulna—	
Length	.093
Breadth, proximal	.041
" distal	.063
Radius—	
Length	.094
Breadth, proximal	.047
" distal	.041

In the plates which accompany this article, the dermal scales are represented of *natural size*, and the slab containing the bones is reduced to *one-ninth* its natural dimensions.

THE IOLA (KANSAS) MINERAL WELL.

By Prof. WILLIAM K. KEDZIE.

At the request of the proprietors, I visited this interesting phenomenon during the month of June, 1876, for the purpose of collecting a supply of water for a thorough analysis. The so-called "well" is, as is well known, simply an old boring by coal prospectors. Its total depth is 736 feet. When at the depth of 626 feet the diamond drill with which the boring was made, suddenly dropped some twenty inches through an apparently vacant seam. A violent upward rush of water and gas immediately began through the tube, and with more or less irregularity has since continued without cessation. The boring is tubed to the depth of 149 feet only. The water is expelled by the elastic force of the gas in very irregular pulsations, at varying intervals escaping alternately first with great impetus and then with a succession of fainter impulses. The sections of the core obtained during the boring present, when arranged in order, a most interesting view of the geological section of this region; especially instructive as it occurs over the Lower Coal

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Measure area of this State. The water of the well is, of course, largely charged with mineral matters, a portion of which being held in solution by the free carbonic acid with which the water abounds, is deposited as a thick sediment upon allowing the water to stand for some time freely exposed to the open air. By repeated and careful experiments, I determined the temperature of the water to be uniformly 61° F., as from the great depth from which the water rises it exhibits little or no variation in temperature through summer or winter. A full analysis of the water presents the following results: Specific Gravity, 1.0138. Temperature, 61° F. Total Mineral Matter to the Imperial Gallon, 1100.081 grains. Carbonic Acid Gas, 145.881 cub. in.

Sodium Chloride	971.506 Grains.
Potassium "	17.909 "
Magnesium "	7.305 "
Sodium Bi-carbonate	8.158 "
Calcium "	60.687 "
Magnesium "	25.485 "
Iron "	3.929 "
Silica	.602 "
Sodium Iodide	Distinct Traces.
Sodium Bromide	Abundant "
Organic Matter	2.000 Grains.
Suspended Matter	2.500 "
Total	1100.081 Grains.

The results of the above analysis have been in all cases duplicated, and in many cases triplicated. Like the product of all mineral wells, this water of course varies somewhat, within slight limits, in its composition. Thus in the water examined by me there was absolutely no trace whatever of sulphates, whereas I observe that Prof. G. E. Patrick, in his paper read before the Academy last year, reports the presence of a very small quantity of Sodium Sulphate. I notice, however, that Mr. Patrick also reports in his analysis an appreciable quantity of Ferric Chloride (Sesqui-Chloride of Iron). If this salt of iron is indeed present in this water it is a most remarkable fact, as there is no well authenticated analysis showing its existence in any mineral spring in the United States. My own analysis indicates no such condition, the iron being present in the water analyzed by me in its usual form in all mineral waters, viz., held in solution as the Bi-carbonate. For the purpose of comparison I give below a tabular view showing the composition of the Iola water as contrasted with that of two of the most noted of the Saratoga Springs, the "Congress" and the "United States:"

IN GRAINS TO THE IMPERIAL GALLON.

	Iola.	Congress.	United States.
Bi-carbonate of Sodium	8.158	7.472	3.240
" Calcium	60.687	99.592	64.672
" Magnesium	25.485	72.152	43.192
" Iron	3.929	.248	.520
" Lithium	.....	2.992	3.040
" Barium	.....	.760	.752
Chloride of Sodium	971.506	400.440	141.872
" Potassium	17.909	8.048	8.604
" Magnesium	7.305	.....	.....
Sulphate of Potassium	.....	.888	.....
Phosphate of Sodium	.....	.016	.016
Iodide of Sodium	Traces.	.136	.048
Bromide of Sodium	Traces.	8.552	.848
Alumina	.....	Traces.	.096
Silica	.602	.840	3.184
Organic Matter	2.000	Traces.	Traces.
Carbonic Acid Gas (cubic inches)	145.891	432	240

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The Iodide and Bromide of Sodium, though in minute amount, are present in very appreciable quantities in the water of the Iola well, and to their influence is undoubtedly due much of the asserted beneficial effects of this water upon scrofulous and other allied difficulties. The Carbonic Acid present in the Iola water is considerably less than that afforded in the waters of the Saratoga Springs, though an abundance is present to remove, by its sparkling influence, much of the disagreeable flavor of the water, which otherwise, from the large amount of mineral matter present, might prove somewhat unpleasant.

The gas, which is thrown from the well with such force and in such quantity, is almost wholly made up of Light Carburetted Hydrogen, commonly known as "Marsh Gas." From its very slight solubility (1 part in 27 by volume, Storer), it of course exists in very small quantities only in the water itself, though it is constantly bubbling up through it. Notwithstanding the views of many observers and writers, the escape of this gas in such abundance from this well is neither anomalous nor startlingly unusual. It is no uncommon occurrence in many portions of the country in sinking similar borings for coal, salt or oil, to find this gas suddenly escaping with force sufficient to stop or reverse the engine. This Light Carburetted Hydrogen is produced in immense quantities in nature from the slow decomposition of all deposits of vegetable matter, and frequently escapes naturally in great abundance. The large supply of this gas near Fredonia, N. Y., by which the entire village is lighted, is too well known to need comment here. Near Oberlin, Ohio, is a spring from which I have frequently discovered the gas escaping in great quantity, forming, when lighted, a flame of large size. Near Kanawha, Va., and at many other places too numerous to mention, this same gas has been known to escape for years without cessation. It is this gas which constitutes the dreaded "fire damp" of our coal mines, the cause of all the terrible disasters and explosions with which the history of coal mining is filled. Points from which it escapes in much the same manner as at Iola, without the efflux of water, are known to the miners as "blowers," and are liable to suddenly appear at any time upon opening a new seam.

Nor, upon the other hand, is it at all necessary, in endeavoring to explain the origin of such large quantities of this gas as escape from the Iola boring, to resort to the popular but very improbable hypothesis of the decomposition of the coal itself by the agency of heat; especially inapplicable to this uniformly undisturbed portion of the Lower Coal Measure of Kansas. There is no evidence to show that this vacant seam of twenty inches encountered at this great depth was originally occupied by a coal bed at all, and such a supposition is not in any way essential. There can be no doubt but that this opening, whether produced by flexure of lower strata or otherwise, communicates laterally with a very large tract of coal-bearing formations, possibly with a good portion of the Western Interior Coal area. And when we remember the fact that this Light Carburetted Hydrogen is given off in large quantities from many varieties of bituminous coal at *ordinary temperatures*, we need be at no loss to account for its appearance at this opening in such considerable amount. It is from this cause that the gas accumulates in coal mines in such dangerous quantities; and it is by no means impossible that this Iola boring may serve as the "vent hole" for a considerable area of coal-bearing territory. This escape of Light Carburetted Hydrogen from soft bituminous coal at ordinary temperatures is of course a continuation of the original coal-forming process: a slow decomposition of vegetable matter under a very limited supply of atmospheric oxygen, in which the gaseous products are principally Light Carburetted Hydrogen with Carbonic Acid (di-oxide), small portions of Carbonic Oxide and occasion-

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ally still smaller quantities of free Hydrogen. The appearance of the Light Carburetted Hydrogen in so liberal quantities at the Iola well, as also the composition of the water brought up by the pulsations of the gas itself, are both matters of very great scientific interest; but neither their interest nor their importance are in any way augmented by ascribing miraculous properties to the one or an anomalous origin to the other.

THE INSECTS OF WALLACE COUNTY, KANSAS.

By Prof. F. H. SNOW, of the University of Kansas.

The Kansas University Scientific Expedition for 1877, in charge of the writer, spent three weeks in camp along the Smoky Hill river, about one mile from Fort Wallace. The elevation of this locality, above the level of the sea is about 3,700 feet. Wallace county is the extreme western county of the State, along the line of the Kansas Pacific Railway. The railway station is 420 miles, by rail, from Kansas City, and 219 miles from Denver. Our collecting ground was therefore very near the center of the plains, or of what was once known as the Great American Desert. The expedition for 1878 spent one month (June 12th to July 12th) in Gove and Wallace counties. Gove county adjoins Wallace county on the east, and the altitude of the railway station at Buffalo is about 3,300 feet above the level of the sea. As the two counties are contiguous, and as their faunal characteristics are apparently identical, the collections of both expeditions are combined in one list. Species taken in Wallace county alone, are marked "W."; those taken in Gove county, alone, are marked "G.", and those taken in both counties are not marked for locality. In the present paper, I include only the orders *Lepidoptera* and *Coleoptera*.

My assistants in 1877, were Messrs. Richard Foster and John M. Walker; in 1878, Richard Foster and Louis L. Dyche. To their indefatigable industry I am largely indebted for the valuable results of the expeditions. I am also indebted to the kindness of Dr. Jno. L. LeConte, of Philadelphia, for the determination of *Coleoptera* not previously known to me.

LIST OF LEPIDOPTERA:

Pieris protodice Bd.-Lec. G.
Nathalis Iole Bd. W.
Colias Eurytheme Bd.
Danais Archippus Fabr.
Argynnis Idalia Drury. G.
Euptoieta Claudia Cram. W.
Phyciodes Tharos Drury. W.
Phyciodes Nycteis Doubl. W.
Grapta interrogationis Fab. var. *umbrosa* Lintner.
Vanessa Antiopa L. W.
Pyrameis Atalanta L.
Pyrameis cardui L.

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Paphia glycerium Doubl. W.
Satyrus Alope Fabr. W.
Thecla humuli Harr.
Lycaena Melissa Edw.
Lycaena acmon West.-Hew. W.
Lycaena Alce Edw. G.
Pamphila Uncas Edw.
Pyrgus tessellata Scud.
Pholisora Catullus Cram. G.
Deilephila lineata Fabr. W.
Proserpinus gauræ Sm.-Abb. W.
Ægeria sp. Three undescribed species. W.
Cerura n. sp. W.
Agrotis Harveyi Grote. W.
Aletia argillacea Hübn. W.
Plusia gamma Linn. W.
Acopia perpallida n. sp. Grote. This species has been described by Prof. Grote in the "Canadian Entomologist" (Vol. X, p. 68), as follows:

"Larger than *carina*, with white secondaries. Primaries white, shaded with ochrey and with narrow fuscous lines. Basal line indicated; anterior line upright, forming two large teeth; outer line denticulate, outwardly produced opposite the cell; orbicular obsolete, reniform concolorous, obscured by a dark shade. Subterminal shade line fuscous, even, continued to vein 7 from internal angle, above which it appears as an inwardly oblique shade from costa to vein 7. A terminal interrupted line; fringes white. Hind wings white, very slightly soiled, with discal mark and in distinct line; fringes white. Beneath yellowish white, shaded with fuscous on primaries; fringes white. Body whitish. *Expanse* 28 mil.

"The median lines on primaries are further apart than in *carina*. This species was sent me by Prof. Snow under the number 504."

Alaria gauræ Sm. W.
Euleucyptera cumatilis Grote. W.
Lygranthœcia jaguarina Guen. W.
Heliochilus paradoxus Grote. W.
Tarache lactipennis Harvey. W.
Drasteria erichtea Cramer.
Brotis vulneraria Hübn. W.
Catocala Nebraskæ Dodge. W.
Catocala amatrix Hub. var. *nurus* Walk. W.
Catocala Ilia Cram. G.
Syneda Howlandi Grote. W
Stegania pustularia Guen. W.
Hæmatopis grataria. Fab.
Conchylis Ridingsana Rob. W.

Number of species, 45.

LIST OF COLEOPTERA:

(The numbers are those of Crotch's check-list.)

CICINDELIDÆ.

1. *Amblychila cylindriformis* Say.
14. *Cicindela pulchra* Say.
15*d*. *Cicindela scutellaris* Say.

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22. *Cicindela purpurea* Oliv. var. *Audubonii* Lec.
25. *Cicindela formosa* Say.
—. *Cicindela venusta* Lec. W.
27. *Cicindela fulgida* Say. W.
43. *Cicindela cuprascens* Lec. G.
46. *Cicindela sperata* Lec. G.
51. *Cicindela punctulata* Fab.
—. *Cicindela micans* Fab.
60. *Cicindela circumpicta* Laf. W.

CARABIDÆ.

73. *Omophron tessellatum* Say. W.
134. *Calosoma scrutator* Fab. G.
141. *Calosoma obsoletum* Say.
200. *Pasimachus elongatus* Lec.
201. *Pasimachus punctulatus* Hald. W.
318. *Galerita janus* Fab. W.
329. *Casnonia Pennsylvanica* L. W.
340. *Loxopeza grandis* Hentz.
382. *Blechrus linearis* Lec. G.
386. *Axinopalpus biplagiatus* Dej. G.
393. *Glycia viridicollis* Lec. W.
398. *Cymindis brevipennis* Zimm.
461. *Platynus extensicollis* Say. W.
463. *Platynus decorus* Say. W.
498. *Platynus nutans* Say. G.
561. *Evarthrus substriatus* Lec.
618. *Pterostichus scitulus* Lec. G.
—. *Amara* sp. An undescribed species. W.
694. *Amara impuncticollis* Say. W.
699. *Amara fallax* Lec.
703. *Amara convexa* Lec. W.
709. *Amara obesa* Say. W.
710. *Amara diffinis* Lec. W.
795. *Chlænius tomentosus* Say.
818. *Cratacanthus dubius* Beauv.
824. *Agonoderus comma* Fab. G.
871. *Anisodactylus sericeus* Harr. G.
916. *Selenophorus pedicularis* Dej.
917. *Selenophorus troglodytes* Dej. G.
928. *Harpalus caliginosus* Fab. W.
933. *Harpalus compar* Lec. G.
942. *Harpalus ventralis* Lec. W.
976. *Stenolophus conjunctus* Say.
1080. *Bembidium cordatum* Lec. G.
1097. *Bembidium intermedium* Kby. G.

HALIPLIDÆ.

1183. *Cnemidotus 12-punctatus* Say.

DYTISCIDÆ.

1185. *Eretes sticticus* Linn. G.

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1208. *Hydroporus patruelis* Lec. G.
1210. *Hydroporus nubilus* Lec. G.
1236. *Hydroporus undulatus* Say. G.
1279. *Laccophilus proximus* Say. G.
1283. *Laccophilus 4-lineatus* Horn. G.
1291. *Thermonectes ornaticollis* Aube. G.
1338. *Coptotomus interrogatus* Fab. G.
1347. *Gaurodytes disintegratus* Cr. G.

GYRINIDÆ.

1389. *Dineutus assimilis* Aube.
1402. *Gyrinus parcus* Say. G.

HYDROPHILIDÆ.

1423. *Helophorus lineatus* Say. G.
1449. *Hydrophilus triangularis* Say. G.
1450. *Tropisternus nimbatus* Say. G.
1454. *Tropisternus sublævis* Lec. G.
1461. *Hydrocharis obtusatus* Say. G.
1465. *Berosus miles* Lec. G.
1477. *Berosus striatus* Say. G.
1499. *Philhydrus perplexus* Lec.
1504. *Philhydrus fimbriatus* Mels. G. Taken by S. W. Williston.
1516. *Hydrobius subcupræus* Say. G.

STAPHYLINIDÆ.

1712. *Tachyporus chrysomelinus* Linn. G.
1771. *Creophilus villosus* Grav.
——. *Philonthus fusiformis* Fauvel MS. G.
1884. *Cryptobium bicolor* Grav W.

SILPHIDÆ.

2175. *Silpha Carolina* Linn. W.
2176. *Silpha marginata* Fab.
2185. *Silpha tomentosa* Web. W.
2188. *Peltis lapponica* Hb. W.
2194. *Peltis truncata* Say. W.
2196. *Peltis Americana* Linn. W.
——. *Agathidium* sp. W.

DERMESTIDÆ.

2392. *Dermestes marmoratus* Say. G.
2394. *Dermestes fasciatus* Lec. W.
2395. *Dermestes nubilus* Say.
——. *Attagenus* sp. G.

TRITOMIDÆ.

2474. *Typhœa fumata* Linn. G.

EROTYLIDÆ.

2506. *Languria Mozardi* Latr. W.
2511. *Languria læta* Lec. G.
2514. *Languria gracilis* Newm. G

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NITIDULIDÆ.

2725. *Carpophilus niger* Say. Taken by S. W. Williston.
2755. *Nitidula ziczac* Say.

PHALACRIDÆ.

——. *Olibrus* sp. G.

COCCINELLIDÆ.

2830. *Hippodamia glacialis* Fab.
2832. *Hippodamia convergens* Guer.
2837. *Hippodamia parenthesis* Say.
2847. *Coccinella 9-notata* Hb.
2853. *Cycloneda sanguinea* Linn. G.
2854a. *Cycloneda abdominalis* Say. G.
2876. *Brachyacantha dentipes* Fab. G.
2897. *Hyperaspidius trimaculata* Linn. G.
2924. *Scymnus cervicalis* Muls. G.

HETEROCERIDÆ.

——. *Heterocerus* sp. G.

HISTERIDÆ.

3037. *Hister Harrisii* Kby.
——. *Hister binotatus* Lec.
3131. *Saprinus lugens* Er. W.
3133. *Saprinus Pennsylvanicus* Payk.
3158. *Saprinus fimbriatus* Lec.

SCARABÆIDÆ.

3223. *Canthon ebenus* Say.
3230. *Canthon hudsonias* Forst. W.
3241. *Phanæus carnifex* Linn. W.
3244. *Onthophagus latebrosus* Fab. W.
3268. *Aphodius granarius* Linn. G.
3283. *Aphodius stercorosus* Mels. W.
3291. *Aphodius concavus* Say. G.
——. *Ataenius* sp. G.
3351. *Bolboceras farctus* Fab. W.
3352. *Bolboceras lazarus* Fab. W.
3377. *Trox suberosus* Fab.
3379. *Trox punctatus* Germ. W.
3381. *Trox Sonorae* Lec.
3394. *Trox atrox* Lec. W.
3482. *Diplotaxis pacata* Lec.
3484. *Diplotaxis Haydenii* Lec. G.
3518. *Lachnosterna crassissima* Blanch. G.
3519. *Lachnosterna prunina* Lec. G.
3520. *Lachnosterna rugosa* Mels. G.
3545. *Lachnosterna glabricula* Lec. W.
3564. *Tostegoptera lanceolata* Say.
3566. *Polyphylla Hammondi* Lec. W.
3588. *Strigoderma arboricola* Fabr. G.
3609. *Ligyrus gibbosus* De Geer.

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3614. *Aphonus pyriformis* Lec. W.
3645. *Euryomia Kernii* Hald. G.
3646. *Euryomia inda* Linn. W.
3650. *Euryomia fulgida* Fabr. G.
3654. *Cremastochilus saucius*. Lec. W.
3659. *Cremastochilus Knochii*, Lec.

BUPRESTIDÆ.

3692. *Dicerca obscura* Fab. W.
3707. *Poecilonota cyanipes* Say. W.
3791. *Acmæodera pulchella* Hbst. G.
3827. *Agrilus pubiventris* Cr.
3833. *Agrilus muticus* Lec.

ELATERIDÆ.

3925. *Lacon rectangularis* Say.
4050. *Drasterius dorsalis* Say. G.
4090. *Monocrepidius auritus* Hbst. G.
4154. *Melanotus verberans* Lec. G.
——. *Melanotus* sp. G.
4355. *Melanactes puncticollis* Lec.

LAMPYRIDÆ.

4448. *Lucidota punctata* Lec. G.

TELEPHORIDÆ.

4481. *Chauliognathus basalis* Lec.
4526. *Telephorus flavipes* Lec. G.
4561. *Ditemnus bidentatus* Say. W.

MALACHIDÆ.

4582. *Collops bipunctatus* Say. W.
4584. *Collops 4-maculatus* Fab. var.
4589. *Collops limbatus* Lec. G.

CLERIDÆ.

——. *Clerus* n. sp.
4722. *Clerus Spinolæ* Lec. G.
4734. *Clerus cordifer* Lec. W.
4740. *Clerus thoracicus* Oliv. G.
4765. *Hydnocera tabida* Lec. G.
4791. *Corynetes rufipes* Fab.

CERAMBYCIDÆ.

4919. *Prionus imbricornis* Linn. G.
4920. *Prionus fissicornis* Hald.
5077. *Batyle ignicollis* Say. G.
5081. *Batyle Pearsalli* Bland. G.
5091. *Crossidius pulchellus* Lec. W.
5094. *Crossidius discoideus* Say. W.
5104. *Cyllene decorus* Oliv. var. *infaustus* Lec. G.
5221. *Typocerus velutinus* Oliv.
5224. *Typocerus sinuatus* Newm. A black variety of this species also occurs.

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5306. *Monilema annulatum* Say.
5404. *Ataxia crypta* Say. W.
5424. *Mecas inornata* Say.
5426. *Mecas gentilis* Lec. G.
5433*a*. *Oberea basalis* Lec. G.
5436. *Oberea oculaticollis* Say. G.
5445. *Tetraopes tetraophthalmus* Forst. W.
5447. *Tetraopes quinquemaculatus* Hald.
5448. *Tetraopes femoralis* Lec.

SPERMOPHAGIDÆ.

5472. *Bruchus discoideus* Say.
5481. *Bruchus pruininus* Horn. Taken by S. W. Williston.
5496. *Bruchus fraterculus* Horn.
5506. *Bruchus seminulum* Horn. W.

CHRYSOMELIDÆ.

5550. *Lema collaris* Say. W.
5554. *Lema trinileata* Oliv. var. G.
5563. *Saxinis omogera* Lac. G.
5569. *Coscinoptera axillaris* Cr.
5571. *Coscinoptera dominicana* Fab. G.
5595. *Cryptocephalus confluens* Say. W.
5631. *Pachybrachys viduatus* Fab. G.
5661. *Pachybrachys litigiosus* Suffr.
5664. *Pachybrachys hepaticus* Mels. G.
——. *Pachybrachys* sp. Two undescribed species.
5687. *Myochrous squamosus* Lec. G.
5693. *Chalcoparia globosa* Oliv. G.
5694. *Paria* 6-*notata* Say. G.
5714. *Colaspis favosa* Say. G.
5715*a*. *Colaspis flavida* Say. W.
——. *Colaspis flavida* Say, var. *lineata*. G.
5716. *Colaspis pretexta* Say. G.
5719. *Colaspis tristis* Oliv. var.
5724. *Chrysomela* 10-*lineata* Say. G.
5729. *Chrysomela exclamationis* Fab.
5733. *Chrysomela disrupta* Rog. G.
5741. *Chrysomela multipunctata* Say. W.
5766. *Plagiodera lapponica* Linn. G.
5772. *Plagiodera oviformis* Lec. G.
5800. *Diabrotica tricincta* Say. W.
5802. *Diabrotica* 12-*punctata* Oliv.
5805. *Diabrotica blandula* Lec.
5831. *Monoxia guttulata* Lec. G.
5834*b*. *Trirhabda Canadensis* Kby. G.
5838. *Trirhabda nitidicollis* Lec. W.
5851. *Œdioychis vians* Ill. W.
5865. *Disonycha alternata* Ill. W.
5870. *Disonycha abbreviata* Mels.
5873. *Disonycha triangularis* Say.

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5882. *Graptodera torquata* Lec. Taken by S. W. Williston.
5886. *Graptodera foliacea* Lec.
5904. *Orchestris vittata* Fab. G.
——. *Orchestris* sp. G.
5912. *Aphthona Texana* Cr. W.
5928. *Crepidodera Helxines* Linn. G.
5941. *Chætocnema subviridis* Lec. G.
5942. *Chætocnema denticulata* Ill. G.
5969. *Microrhopala cyanea* Say. W.
5977. *Chelimorpha Lewisii* Cr. W.
5980*b*. *Cassida ellipsis* Lec.

TENEBRIONIDÆ.

6002. *Trimytis pruinosa* Lec. W.
6010. *Epitragus canaliculatus* Say. W.
6068. *Asida opaca* Say.
6070. *Asida polita* Say. W.
6071. *Asida sordida* Lec. W.
6092. *Asida convexa* Lec. W.
6097. *Asida elata* Lec. W.
6098. *Ologlyptus anastomosis* Say.
6105. *Eusattus reticulatus* Say. G.
6128. *Eleodes acuta* Say.
6129. *Eleodes suturalis* Say.
6129*a*. *Eleodes Texana* Lec.
6131. *Eleodes tricostata* Say.
6133. *Eleodes obsoleta* Say.
6137. *Eleodes extricata* Say.
6141. *Eleodes longicollis* Say.
6150. *Eleodes hispilabris* Say.
6167. *Eleodes opaca* Say.
6174. *Embaphion muricatum* Say. W.
6175. *Embaphion contusum* Lec. G.
6222. *Tenebrio obscurus* Fab. G.
6244. *Blapstinus pratensis* Lec.
6245. *Blapstinus vestitus* Lec. W.

ALLECULIDÆ.

6375. *Hymenorus obscurus* Say. W.

ANTHICIDÆ.

6458. *Notoxus subtilis* Lec.
——. *Notoxus* sp. W.

MORDELLIDÆ.

6583. *Anaspis rufa* Say. G.
6593. *Mordella melæna* Germ.
6594. *Mordella scutellaris* Fabr. G.
6602. *Mordella oculata* Say. G.
6648. *Mordellistena unicolor* Lec.
6662. *Mordellistena suturella* Helmuth. G.

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MELOIDÆ.

6711. *Tricrania Stansburii* Hald. G.
6713. *Macrobasis albida* Say. W.
6721. *Macrobasis fulvescens* Lec. W.
6722. *Macrobasis segmentata* Say.
——. *Epicauta trichrus* var. G.
6731. *Epicauta ferruginea* Say.
6732. *Epicauta sericans* Lec. W.
6738. *Epicauta maculata* Say.
6746. *Epicauta corvina* Lec. W.
6747. *Epicauta Pennsylvanica* DeG. W.
6750. *Pyrota mylabrina* Chev. W.
6779. *Cantharis reticulata* Say. W.
6803. *Zonitis atripennis* Say. W.
6807. *Nemognatha sparsa* Lec. W.
6808. *Nemognatha bicolor* Lec. W.
6809. *Nemognatha lurida* Lec.
6810. *Nemognatha apicalis* Lec.
6816. *Nemognatha piezata* Fabr. W.
6825. *Nemognatha immaculata* Say. W.
6830. *Gnathium minimum* Say.

RHYNCHITIDÆ.

Rhynchites hirtus Oliv.

BYRSOPIDÆ.

Thecesternus humeralis Say, race *rudis* Lec.

OTIORHYNCHIDÆ.

Epicærus imbricatus Say.
Ophryastes vittatus Say. W.
Ophryastes tuberosus Lec.
Ophryastes sulcirostris Say. W.
Phacepholis elegans Horn.

CURCULIONIDÆ.

Sitones tibialis Germ.
Phytonomus eximius Lec. G.
Listronotus sp. G.
Cleonus trivittatus Say. G.
Cleonus frontalis Lec. W.
Lixus terminalis Lec. G.
Lixus mucidus Lec. G.
Dorytomus squamosus Lec. G.
Smicronyx fulvus Lec. W.
Endalus limatulus Lap. G.
Anthonomus fulvus Lec.
Anthonomus squamosus Lec.
Anthonomus sp. G.
Macrorhoptrus estriatus Lec.

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Rhyssematus lineaticollis Say.
Acalles turbidus Lec.
Tyloderma foveolatum Say. G.
Copturus operculatus Gyll.
Ceutorhynchus sp. G.
Ceutorhynchus decipiens Lec.
Rhinoncus pericarpius Gyll. G.
Rhinoncus pyrrhopus Boh. G.
Orthoris Crotchii Lec. G.
Trichobaris trinotata Say. G.
Baris transversa Say. W.
Baris macer (?). G.
Baris pruinosa Lec. G.

CALANDRIDÆ.

Sphenophorus vomerinus Lec. var. *baridioides.*
Rhodobænus 13-*punctatus* Ill.
Cossonus certicola Say. W.

APIONIDÆ.

Apion sp. An undescribed species.

SUMMARY OF SPECIES OF COLEOPTERA.

Cicindelidæ	10	Lampyridæ	1
Carabidæ	35	Telephoridæ	3
Haliplidæ	1	Malachidæ	3
Dytiscidæ	9	Cleridæ	6
Gyrinidæ	2	Cerambycidæ	18
Hydrophilidæ	10	Spermophagidæ	4
Staphylinidæ	4	Chrysomelidæ	46
Silphidæ	7	Tenebrionidæ	23
Dermestidæ	4	Alleculidæ	1
Tritomidæ	1	Anthicidæ	2
Erotylidæ	3	Mordellidæ	6
Nitidulidæ	2	Meloidæ	20
Phalacridæ	1	Rhynchitidæ	1
Coccinellidæ	9	Byrsopidæ	1
Heteroceridæ	1	Otiorhynchidæ	5
Histeridæ	5	Curculionidæ	27
Scarabæidæ	30	Calandridæ	3
Buprestidæ	5	Apionidæ	1
Elateridæ	6		
Total		Families, 37; Species	316

LIST OF LEPIDOPTERA.

Collected in Colorado in June, July and August, 1876, by the Kansas University Scientific Expedition.

By Prof. F. H. SNOW.

A list of the Coleoptera taken in Colorado by the expedition in my charge, was published in Vol. V of the Transactions of this Academy (pp. 15—20). The following Lepidoptera were collected by the same party. For the determination of species previously unknown to me, I am indebted to Wm. H. Edwards, Esq., of Coalburgh,

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West Va., and to Prof. A. R. Grote, of Buffalo, N.Y. Included also in this list are a few additional species taken in Platte Cañon, in July, 1878.

LEPIDOPTERA RHOPALOCERA.

Papilio Zolicaon Bdl. A single specimen was taken in Platte Cañon at an altitude of 8,000 feet.

Papilio Eurymedon Bdl. Found in considerable numbers at an elevation of 8,000 to 10,000 feet, about the summits of rocky peaks.

Papilio Rutulus Bdl. Taken in open woods along the Ute Pass road—7,000 to 9,000 feet.

Papilio Daunus Edwards. Not uncommon in Engelmann's Cañon and other cañons, at an altitude of 6,000 to 8,000 feet. This species is very swift in flight, and exceedingly difficult to capture.

Parnassius Smintheus Doub. Found at all elevations from 7,000 to 13,000 feet. Specimens from above timber line on Pike's Peak, have the wings nearly transparent. One or two examples of var. *Behrii* Edw., were captured on Pike's Peak.

Pieris Protodice Bdl.-Lec. Common at Colorado Springs, in Engelmann's Cañon, and at other low elevations.

Pieris oleracea Bdl. Only two or three specimens were seen—these being at an elevation of 9,000 feet.

Nathalis Iole Boisd. Taken occasionally at low elevations.

Colias Eurytheme Bdl. Taken at all elevations below 10,000 feet. Var. *Keewaydin* Edw., also occurred.

Colias Meadii Edw. Abundant above timber line on Pike's Peak—altitude 13,000 feet.

Colias Alexandra Edw. Taken along the Upper Arkansas, also in Platte Cañon, near Dome Rock, at an altitude of 7,500 feet.

Colias Philodice Godart. Specimens of this species differ somewhat from the Eastern form, and are considered by Mr. W. H. Edwards to constitute a distinct species.

Terias Mexicana Bdl. Taken in Jones's Park, along the Signal Service Trail to Pike's Peak, also near Dome Rock in Platte Cañon.

Danais Archippus Fab. Found at all elevations up to timber line.

Euptoieta Claudia Cramer. Found abundantly at same elevations with the last species.

Argynnis Aphrodite Fab. var. *Alcestis* Edw. Common in Engelmann's Cañon, and Platte Cañon, at middle elevations.

Argynnis Edwardsii Reakirt. Frequent in same localities with the preceding.

Argynnis Meadii Edw. Taken in the Platte Cañon.

Argynnis Eurynome Edw. A single specimen was obtained in the Upper Arkansas valley.

Argynnis Helena Edw. Found at high elevations, extending above the timber line nearly to the summit of Pike's Peak, 14,000 feet above the sea.

Melitæa nubigena Behr. Taken at all elevations from 7,000 feet to timber line. I am unable to detect any specific difference between this species and *M. Anicia* Doub.

Melitæa Gabbii Behr. This species had not previously been taken in Colorado. Only one specimen was secured — below timber line on Pike's Peak.

Melitæa minuta Edw. Not before taken in Colorado. Several specimens were obtained by our party in the South Park.

Phyciodes Tharos Drury, var. *Marcia* Edw. Common in the Ute Pass.

Phyciodes Camillus Edw. Abundant in the cañons at low and middle elevations.

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Grapta Satyrus Edw. A rare species, though found in three different localities, Engelmann's Cañon, Clear Creek Cañon, and Platte Cañon.

Grapta Zephyrus Edw. Common along the Ute Pass road.

Vanessa Antiopa Linn. Not common, but quite generally distributed at low and middle elevations.

Vanessa Milbertii Godt. Rarely seen at all elevations. Two fresh specimens were taken above timber line on Pike's Peak, at an elevation of 13,000 feet.

Pyrameis cardui L. A single specimen of this "cosmopolitan" was taken above timber line on Pike's Peak. It was often seen at lower elevations.

Junonia Lavinia Cram. Platte Cañon, near "Dome Rock."

Limenitis Weidemeyerii Edw. Common in Engelmann's Cañon and along the Ute Pass road, at an elevation of 8,000 feet.

Cœnonympha ochracea Edw. Taken frequently along the Ute Pass road, and in South Park.

Satyrus nephele Kirby. A single specimen was taken in Platte Cañon.

Satyrus Charon Edw. Found abundantly in Engelmann's and Platte Cañons, at 6,000 to 8,000 feet elevation.

Satyrus Meadii Edw. Taken frequently in Platte Cañon, at 6,000 to 8,000 feet elevation.

Satyrus Ridingsii Edw. Abundant on the plains about Colorado Springs.

Erebia Epipsodea Butler. Found in the small cañons along the east border of South Park, at an elevation of 9,000 to 10,000 feet.

Chionobas Uhlerii Reakirt. Taken rarely along the Ute Pass road, at low elevations.

Chionobas Chryxus West.-Hew. More common than the preceding, and reaching to higher elevations.

Chionobas semidea Say. Seen abundantly on the summit of Pike's Peak, 13,000 to 14,000 feet elevation.

Thecla Crysalus Edw. Taken abundantly on oaks in Engelmann's and Platte Cañons, at 6,000 to 8,000 feet elevation.

Thecla humuli Harr. Not uncommon at Manitou and in Engelmann's Cañon.

Thecla Strigosa Harr. Not before taken in Colorado.

Thecla Calanus Hüb. Not previously taken in Colorado.

Thecla Sæpium Bd.

Thecla Behrii Edw. Not previously recorded from Colorado. This and the three preceding species were taken in Platte Cañon at an altitude of 7,000 feet.

Thecla Mopsus Hübner. Taken along the Ute Pass road, near the South Park.

Thecla Eryphon Bd. A single specimen—locality not noted.

Chrysophanus Nais Edw. Taken in the Platte Cañon; not previously reported from Colorado.

Chrysophanus Ianthe Edw. One specimen was taken in the Upper Arkansas valley.

Chrysophanus Virginiensis Edw. Taken abundantly in Engelmann's and Platte Cañons; not previously recorded from Colorado.

Chrysophanus Sirius Edw. A single specimen was taken in Engelmann's Cañon.

Lycæna heteronea Bdl. One specimen only, taken at Dome Rock in Platte Cañon.

Lycæna Lycea Edw. Common about Colorado Springs; taken also in South Park.

Lycæna Sæpiolus Bd. var. *Aehaja* Behr. South Park.

Lycæna Orbitulus Von Prunner. Taken along the upper portion of the Ute Pass road.

Lycæna Glaucon Edw. One or two specimens only were taken in the South Park.

Lycæna Melissa Edw. Common in the South Park.

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Lycæna Acmon West.-Hew. Abundant at Colorado Springs and in South Park.

Lycæna Isola Peak. Colorado Springs and South Park; not common.

Ancyloxypha Hylax Edw. Several specimens were taken along the Ute Pass road.

Pamphila Hobomok Harr. Taken in Engelmann's Cañon and the Ute Pass.

Pamphila Comma Linn. This species in the forms *Manitoba* and *Nevada* was obtained in the South Park in considerable numbers.

Pamphila Uncas Mdw. Common about Colorado Springs and in the South Park.

Pamphila Snowi Edw. This was the only new "diurnal" taken by our expedition. It was named and described by Mr. W. H. Edwards. The following is the description as given by him in the *Canadian Entomologist*, Vol. IX, pp. 29, 30:

"Male—expands 1.1 inch.; size and shape of *Leonardus*, the hind wings somewhat less prolonged anteriorly.

"Upper side of both wings light glossy brown; primaries have five translucent spots, namely, one sub-apical, oblong, narrow, cut into three equal parts by the subcostal nervules; three discal, the first being at the top of the upper median interspace, small, semi-oval; the next large, irregularly quadrate, crossing the next lower interspace, and the third on sub-median interspace, less transparent, more yellow, in one example clearly defined, sub-triangular, in the other diffuse; these three spots forming an oblique line back of and below the cell; the fifth spot is at the outer end of the cell, a narrow transverse bar; the stigma long, narrow, a little sinuous on the middle, black, edged in the middle by rough dark brown scales on either side.

"Secondaries have an abbreviated discal row of indistinct, small yellow spots, placed nearly parallel to the hind margin, and restricted to the discoidal and median interspaces, or very nearly so; in the middle of the cell a small yellowish spot, almost obsolete; fringes cinereous, those of secondaries lighter than the others.

"Under side of both wings brown with a russet tint; primaries somewhat fuscous near base, in and below cell, and pale yellow in the sub-median interspace; the spots repeated except the lower of the three, which is lost in the color of the interspace just mentioned; secondaries have the discal spots more distinct, yellowish, and there appear faint traces of obsolete spots which would complete the series to costal margin; the cellular spot small, distinct, rounded.

"Body above brown, below the thorax gray-brown, above the collar yellow-tipped; abdomen yellow-gray; legs brown; palpi sordid white, gray at tips; antennæ fuscous above, grayish below; club fuscous for a narrow space on upper side, elsewhere russet.

"From 2 ♂, sent me by Prof. F. H. Snow, and taken by him in Colorado, at Ute Pass, while in charge of the Kansas University Scientific Expedition, 1876. No others were taken, as I am informed.

"The species is near *Leonardus*, from which it differs in not having the basal area of primaries fulvous, in not having two spots near hind margin in the discoidal interspace, in having the spots translucent instead of fulvous, and in having a distinct spot at end of cell; the stigma of *Leonardus* differs considerably also, being heavier, somewhat curved, and especially broken in on the lower median nervule, of which the posterior part is thrown back of the line of the remainder; the spots on disk of secondaries in *Leonardus* are placed as in the present species, but are larger, and either quite distinct or largely diffuse, examples varying. The under side of *Leonardus* is more red (cinnamon-brown), and the series of spots on secondaries is complete and distinct, as is also the cellular spot. In these wings the resemblance between the two species is closer than elsewhere. They form a very interesting group."

Mr. H. K. Morrison, in 1877, found this species quite abundantly in Southern Colorado.

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Pamphila Metacomet Harr. Taken in the Chiann Cañon. Not previously reported from Colorado.

Pamphila Osyka Edw. Taken along the Ute Pass road. This species is also new to the Colorado list.

Pyrgus tessellata Scud. Common at low elevations.

Nisoniades Persius Scud. Taken in Engelmann's Cañon and along the Ute Pass road.

Pholisora Catullus Cram. In Engelmann's and Platte Cañons.

Eudamus Tityrus Fabr. In same localities as the preceding.

LEPIDOPTERA HETEROCERA.

Sesia axillaris Grote. Two specimens were taken at Dome Rock in the Platte Cañon.

Deilephila lineata Fab. Colorado Springs and Manitou.

Ægeria sp. An undescribed species, was taken in Engelmann's Cañon.

Alypia octomaculata Fab. Taken in the Ute Pass, about one mile from Manitou.

Gnophæla vermiculata Grote. Common along Bear Creek on the Signal Service trail to Pike's Peak.

Ctenucha Cressoniana Grote. Four specimens were taken along the Ute Pass road, at an altitude of 7,500 feet.

Anatolmis Grotei Packard. Abundant in August in the Ute Pass just beyond Manitou.

Hepialus pulcher Grote. Three specimens were taken along Ute Pass road—altitude, 7,000 feet.

Leucarctia acræa Sm. A pair was taken in a garden at Colorado Springs.

Crocota sp. An undetermined species, from Engelmann's Cañon.

Nemeophila petrosa Walker. Engelmann's Cañon.

Tolype velleda Stall. Engelmann's Cañon.

Ecpantheria reducta Grote. A new species, taken at our camp in Engelmann's Cañon, about one mile from Manitou, near the famous "Iron Spring." This locality is denoted, whenever Engelmann's Cañon is given in this list as the locality of capture.

Agrotis gularis Grote. Engelmann's Cañon.

Agrotis auxiliaris Grote. Engelmann's Cañon.

Agrotis stigmosa Morr. Engelmann's Cañon.

Hadena devastatrix Grote. Engelmann's Cañon.

Plusia epigæa Grote. Engelmann's Cañon.

Anarta melanopa Thunb. Taken above timber line on Pike's Peak—altitude, 13,000 feet. This species is also found upon Mt. Washington, N. H., in Labrador, and upon the Alps.

Euleucyptera cumatilis Grote. Taken at "Dome Rock" in Platte Cañon—altitude, 7,500 feet.

Antaplaga dimidiata Grote. A new genus and species taken in Engelmann's cañon. The following is Prof. A. R. Grote's description, as published in the *Canadian Entomologist*, Vol. IX, p. 71 :

"Head, thorax and basal third of fore wings white. Beyond, the wing is blackish brown, limited obliquely and a little unevenly from the white basal portion by the difference in color. A whitish subterminal shade. A discal mark obscurely indicated on the darker portion of the wing. Hind wings pale fuscous with white fringe ; beneath whitish. Fore wings beneath fuscous. *Expanse* 30 mil. *Hab.* Colorado, Prof. Snow."

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Melicleptria villosa Grote. A pair was taken in Engelmann's Cañon.
Lygranthœcia brevis Grote. Engelmann's Cañon.
Catocala Walshii Edw. Taken in Colorado Springs; also in Engelmann's and Clear Creek Cañons.
Catocala aholibah Strecker. Engelmann's Cañon.
Syneda Howlandii Grote. Vicinity of Colorado Springs.
Chlorosea biseriata Pack. Engelmann's Cañon.
Tetracis Coloradaria Pack. Engelmann's Cañon.
Endropia pectinaria. Engelmann's Cañon.
Thamnonoma subcessaria Walk. Engelmann's Cañon.
Eurycreon sticticalis Linn. Engelmann's Cañon.
Asopia sp. An undetermined species. Engelmann's Cañon.
Conchylis Ridingsana Robinson. Engelmann's Cañon.
Number of species: *Rhopalocera*, 71; *Heterocera*, 33. Total *Lepidoptera*, 104.

LIST OF COLEOPTERA,

Collected near "Dome Rock," Platte Cañon, Colorado, by the Kansas University Scientific Expedition for 1878.

By Prof. F. H. SNOW.

Our collecting party spent twelve days (July 12th to 26th,) in the above locality, thirty-one miles from Denver. Our camp was fixed at an estimated elevation of 7,500 feet above the level of the sea. My assistants were Messrs. Richard Foster and L. L. Dyche, students of the University. The collections consisted chiefly of plants, insects and birds. The following list is presented as a slight contribution to a better knowledge of the geographical distribution of American Coleoptera. My acknowledgments are due to Dr. John L. Le Conte and Dr. Geo. H. Horn, of Philadelphia, for the determination of species not previously in my cabinet. The numbers are those of Crotch's check-list.

22. *Cicindela purpurea* Oliv., var. *Audubonii* Lec.
30. *Cicindela 12-guttata* Dej.
160. *Carabus tædatus* Fab.
428. *Calathus ingratus* Dej.
514. *Platynus placidus* Say.
581. *Pterostichus protractus* Lec.
699. *Amara fallax* Lec.
709. *Amara obesa* Say.
1067. *Bembidium lucidum* Lec.
1723. *Boletobius dimidiatus* Er.
1977. *Bledius ruficornis* Lec.
2396. *Dermestes talpinus* Mann.
——. *Anthrenus* sp.
2434*a*. *Orphilus subnitidus* Lec.
2541. *Cypherotylus Boisduvali* Chev.
2681. *Nemosoma cylindricum* Lec.

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2682. *Trogosita virescens* Fab.
2749. *Epuræa truncatella* Mann.
2755. *Nitidula ziczac* Say.
2767. *Meligethus ruficornis* Lec.
2853. *Cycloneda sanguinea* Linn.
2858. *Harmonia picta* Rand.
2882. *Hyperaspis fimbriolata* Mels.
2928. *Scymnus lacustris* Lec.
——. *Aphodius rudis* Lec.
3560. *Listrochelus falsus* Lec.
3715. *Buprestis consularis* Gory.
3716. *Buprestis Nuttalli* Kirby.
3718. *Buprestis maculiventris* Say.
3723. *Buprestis* (near) *adjecta* Lec.
3734. *Melanophila Drummondi* Kirby.
3736. *Melanophila gentilis* G. and H.
3738. *Anthaxia inornata* Rand.
3753. *Chrysobothris dentipes* Germ.
3791. *Acmæodera pulchella* Hbst.
——. *Microrrhagus* sp.
3902. *Anelastes Drurii* Kirby.
——. *Corymbites* n. sp.
4333. *Asaphes coracinus* Cand.
——. *Dictyoptera rubripennis* Lec.
1450. *Photinus corruscus* Linn.
4578. *Collops eximius* Er.
4628. *Attalus morulus* Lec.
——. *Clerus* n. sp.
4716. *Clerus ornatus* Say.
4718. *Clerus Nuttalli* Kirby.
4746. *Clerus undulatus* Say.
4821. *Oligomerus sericans* Mels.
4918. *Prionus Californicus* Motsch.
4964. *Callidium hirtellum* Lec.
5051. *Rhopalophera longipes* Say.
5077. *Batyle ignicollis* Say.
5081. *Batyle Pearsalli* Bland.
5195. *Acmæops tumida* Lec.
5204. *Acmæops proteus* Kirby.
5257*a*. *Leptura convexa* Lec.
5265. *Leptura carbonata* Lec.
5272. *Leptura sanguinea* Lec.
5276. *Leptura chrysocoma* Kirby.
5321. *Monohammus maculosus* Hald.
5323. *Monohammus scutellatus* Say.
5357. *Sternidius alpha* Say.
5388. *Pogonocherus mixtus* Hald.
——. *Oberea quadricallosa* ——.
5585*a*. *Cryptocephalus mammifer* Newm.
5614. *Cryptocephalus auratus* Fab.
5642. *Pachybrachys atomarius* Mels.

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5668. *Xanthonia 10-notata* Say.
5672. *Heteraspis marcassita* Germ.
5689. *Chrysochus cobaltinus* Lec.
5719*b*. *Colaspis puncticollis* Say.
——. *Chalcophana placida* ——.
5738. *Chrysomela disrupta* Rog.
5837. *Trirhabda convergens* Lec.
5886. *Graptodera foliacea* Lec.
——. *Graptodera bimarginata* Say.
6124. *Coniontis ovalis* Esch.
6202. *Iphthimus serratus* Mannh.
6357. *Helops convexulus* Lec.
6374. *Hymenorus pilosus* Mels.
6450. *Notoxa anchora* Hentz.
——. *Pentaria rugicollis* Lec.
6578. *Anaspis nigra* Hald.
6583. *Anaspis rufa* Say.
6593. *Mordella melæna* Germ.
6594. *Mordella scutellaris* Fab.
6731. *Epicauta ferruginea* Say.
6809. *Nemognatha lurida* Lec.
6825. *Nemognatha immaculata* Say.
——. *Mycterus* n. sp.
6874. *Crymodes discicollis* Say.
7017. *Lepyrus geminatus* Say.
——. *Magdalis Le Contei* ——.
——. *Magdalis cuneiformis* ——.
7106. *Balaninus nasicus* Say.
——. *Anthonomus squamosus* Lec.
7322. *Pityopthorus retusus* Lec.
——. *Pityophthorus* sp.
7364. *Tomicus pini* Say.

Number of species, 99.

ADDITIONS TO THE CATALOGUE OF KANSAS COLEOPTERA.

By E. A. POPENOE, Topeka.

The following list of additions to the Catalogue of Kansas Coleoptera includes in great part the results of the collections of 1877 and 1878, made in different localities by Prof. F. H. Snow and the writer. The species were determined by Dr. John L. Le Conte, of Philadelphia, to whom thanks are due for many favors. Those species noted from Lawrence are added by Prof. Snow. The additions number 435, increas ing the list total to 1711 species.

49. *Cicindela lepida* Dej. Lawrence; taken by A. E. Blood.
67. *Cicindela Pilatii* Guer. Lawrence; taken by C. B. Cramer.

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221. *Dyschirius haemorrhoidalis* Dej. Topeka; common in mud on the creek banks.
233. *Dyschirius filiformis* Lec. Lawrence.
242. *D. hispidus* Lec. Less common than No. 221; found in the same localities.
246. *Ardistomis viridis* Say. Topeka and Lawrence.
252. *Clivina impressifrons* Lec. Lawrence.
261. *Clivina Americana* Dej. Lawrence.
266. *Clivina ferrea* Lec. Lawrence.
—. *Clivina* new species. Topeka.
292. *Brachynus alternans* Dej. Lawrence.
296. *Brachynus fumans* Fab., var. *similis* Lec. Wallace county (Snow).
300. *Brachynus stygicornis* Say. Western Kansas.
309. *Micrixys distinctus* Hald. Peabody, from C. P. Arbuthnot.
352. *Lebia viridipennis* Dej. Topeka and Lawrence.
364. *Aphelogenia fuscata* Lec. Lawrence (Snow), and West Kansas (Cooper).
386. *Axinopalpus biplagiatus* Dej. Gove county (Snow).
393. *Glycia viridicollis* Lec. Lawrence, and Gove county.
448. *Platynus pusillus* Lec. Lawrence.
461*b*. *Platynus viridis* Lec. Topeka.
484. *Platynus rubripes* Zimm. Lawrence.
501. *Platynus sordens* Kby. Topeka; rare.
503. *Platynus ruficornis* Lec. Lawrence.
—. *Platynus cinctus*. Lawrence.
—. *Platynus* new species.
563. *Evarthrus incisus* Lec.
618. *Pterostichus scitulus* Lec. Western Kansas.
619. *Pterostichus lætulus* Lec. Lawrence.
626. *Pterostichus lucublandus*, var. *bicolor* Lec. Topeka; two specimens; also at Lawrence.
643*a*. *Pterostichus desidiosus* Lec. Lawrence.
672. *Amara laticollis* Lec. Topeka.
693. *Amara basilaris* Say. Lawrence.
703. *Amara convexa* Lec. Wallace county (Snow).
709. *Amara obesa* Say. Western Kansas.
710. *Amara diffinis* Lec. Wallace county (Snow).
712. *Amara chalcea* Dej. Western Kansas.
717. *Amara gibba* Lec. Topeka and Lawrence.
—. *Amara fulvipes* Putz. Topeka; one specimen; also at Lawrence.
—. *Amara cupreolata* Putz. Topeka and Lawrence.
726. *Badister pulchellus* Lec. Lawrence.
729. *Badister micans* Lec. Lawrence.
748. *Dicælus furvus* Say. Topeka; a single specimen taken.
794. *Chlænius purpuricollis* Randall. Lawrence.
796. *Atranus pubescens* Dej. Topeka; two specimens.
801. *Oodes amaroides* Dej. Lawrence.
827. *Agonoderus partiarius* Say. Topeka.
851. *Anisodactylus Harrisii* Lec. Lawrence.
859. *Anisodactylus discoideus* Dej. Lawrence.
—. *Anisodactylus agricola* Say. Topeka; frequent.
913. *Selenophorus opalinus* Lec. Lawrence.
916. *Selenophorus pedicularis* Dej. Wallace county (Snow).

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921. *Selenophorus ellipticus* Dej. Lawrence.
942. *Harpalus ventralis* Lec. Wallace county (Snow).
—. *Stenolophus* new species. Topeka; one specimen.
975. *Stenolophus plebeius*, var. *fuscatus* Dej. Lawrence.
1058. *Bembidium perspicuum* Lec.
1063. *Bembidium striola* Lec. Lawrence.
1096. *Bembidium variegatum* Say.
1099. *Bembidium versicolor* Lec.
1110. *Bembidium affine* Say. Topeka and Lawrence.
1127. *Tachys proximus* Say. Lawrence.
1154. *Tachys ferrugineus* Dej. Topeka; one specimen.
1158. *Tachys nebulosus* Chd. Topeka; one specimen.
1188. *Hydrovatus cuspidatus* Germ. Lawrence.
1201. *Hydroporus dissimilis* Harris. Lawrence.
1208. *Hydroporus patruelis* Lec. Lawrence, and Gove county.
1217. *Hydroporus lacustris* Say. Topeka; abundant where found.
1236. *Hydroporus undulatus* Say. Gove county (Snow).
1262. *Hydroporus concinnus* Lec. Topeka; not rare.
1283. *Laccophilus 4-lineatus* Horn. Gove county (Snow).
1291. *Thermonectes ornaticollis* Aubé. West Kansas; also at Lawrence.
1291*a*. *Thermonectes nigrofasciatus* Aubé. Topeka.
1322. *Rhantus notatus* Fab. Lawrence.
1326. *Rhantus calidus* Fab.
1347. *Gaurodytes disintegratus* Cr. Lawrence.
1349. *Gaurodytes semivittatus* Lec.
1356. *Gaurodytes obliteratas* Lec. Lawrence.
1365. *Gaurodytes* (near) *parallelus* Lec. Lawrence.
1400. *Gyrinus maculiventris* Lec.
1402. *Gyrinus parcus* Say. Western Kansas (Cooper and Snow).
1454. *Tropisternus sublævis* Lec. Western Kansas (Cooper and Snow).
1465. *Berosus miles* Lec. Gove county (Snow).
1471. *Berosus pantherinus* Lec. Lawrence.
1472. *Berosus peregrinus* Hb.
1489. *Philhydrus nebulosus* Say.
1493. *Philhydrus ochraceus* Mels. Topeka and Lawrence; rare.
1494. *Philhydrus reflexipennis* Zimm (?).
1504. *Philhydrus fimbriatus* Mels. Gove county (S. W. Williston).
1516. *Hydrobius subcupreus* Say. Gove county (Snow).
1534. *Cercyon prætextum* Say. Topeka; not rare, and found under decaying vegetable refuse.
—. *Trichopteryx* sp. Lawrence.
1710. *Tachyporus nanus* Er. Lawrence.
1763. *Quedius capucinus* Grav. Lawrence.
1780. *Staphylinus exulans* Er. Western Kansas.
1787. *Staphylinus cinnamopterus* Grav. Lawrence.
1799. *Ocypus ater* Grav. Lawrence.
1803. *Philonthus æneus* Rossi. Lawrence.
1821. *Philonthus lomatus* Er. Topeka and Lawrence.
1834. *Philonthus apicalis* Say. Lawrence.
1835. *Philonthus sobrinus* Er. Topeka and Lawrence.
—. *Philonthus fusiformis* Fauvel Ms. Gove county (Snow).

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——. *Philonthus* sp. Two undescribed species. Lawrence.
——. *Xantholinus fusciceps* Fauvel. Lawrence.
1880. *Lathrobium collare* Er. Lawrence.
1881. *Lathrobium dimidiatum* Say.
1894. *Stilicus tristis* Mels. Lawrence.
——. *Bledius confusus* ——. Lawrence.
1991. *Oxytelus fuscipennis* Mann. Lawrence.
1995. *Oxytelus nitidulus* (?) Grav. Lawrence.
2001. *Apocellus sphæricollis* Say. Lawrence.
2012. *Anthophagus verticalis* Say. Lawrence.
2019. *Acidota subcarinata* Er. Lawrence.
2046. *Omalium repandum* Er. Lawrence.
2095. *Ctenistes piceus* Lec. Topeka.
2100. *Tyrus humeralis* Aubé. Topeka.
2103. *Tychus longipalpus* Lec. Topeka.
2124. *Bryaxis rubicunda* Aubé. Topeka.
2149. *Batrisus globosus* Lec. Lawrence.
2175. *Silpha Carolina* L. Wallace county (Snow).
——. *Agathidium* sp. Gove county (Snow).
2312. *Sericoderus flavidus* Lec. Lawrence.
2335. *Scaphisoma suturale* Lec. Topeka.
2336. *Scaphisoma terminatum* Mels. Topeka.
2340. *Toxidium compressum* Zimm. Lawrence.
2417. *Trogoderma pallipes* Ziegl. Lawrence.
2426. *Cryptorhopalum hæmorrhoidale* Lec. Lawrence.
2441. *Mycetina morosa* Lec. West Kansas (Cooper).
2468. *Litargus sexpunctatus* Say. Topeka and Lawrence; frequent.
——. *Ceracis* sp. Lawrence.
2504. *Ceracis Sallei* Mell. Topeka; in fungi; common
2511. *Languria læta* Lec. Gove county (Snow).
2514. *Languria gracilis* Newm. Gove county (Snow); Tonganoxie (T. B. Ashton).
——. *Atomaria* new species. Topeka and Lawrence.
2581. *Silvanus bidentatus* Fabr. Topeka.
2590. *Telephanus velox* Hald. Topeka; one specimen.
2599. *Læmophlæus fasciatus* Mels. Topeka.
2601. *Læmophlæus testaceus* Fab. Topeka.
2605. *Læmophlæus adustus* Lec. Topeka.
2666. *Bactridium nanum* Er. Lawrence.
2688*a*. *Trogosita intermedia* Horn. Topeka.
2688*b*. *Trogosita dubia* Horn. Lawrence.
2717. *Colastus semitectus* Say. Topeka; under the bark on freshly cut willow stumps, feeding on the sap.
2719. *Colastus truncatus* Rand. With the last named.
2725. *Carpophilus niger* Say. Topeka, and West Kansas.
2731. *Carpophilus brachypterus* Say. Topeka; very abundant in early spring (1878) on blooming willow catkins.
2743. *Epuræa labilis* Er. Topeka; three specimens.
2757. *Lobiopa undulata* Say. Topeka; four specimens, taken in July, on the ground, under decaying fruit.
2813. *Olibrus semistriatus* Lec.

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——. *Olibrus ergoti* Walsh Ms. Lawrence.
2827. *Hippodamia 5-signata* Kby.
2867. *Psyllobora 20-maculata* Say. Topeka and Lawrence.
2871. *Exochomus Pilatii* Muls. Lawrence.
2877*a*. *Brachyacantha 10-pustulata* Mels. Lawrence.
2877*d*. *Brachyacantha albifrons* Say. West Kansas.
2897. *Hyperaspidius trimaculata* L. West Kansas.
2900. *Scymnus amabilis*. Lec.
2906. *Scymnus terminatus* Say. Lawrence.
2909. *Scymnus Americanus* Muls. Lawrence.
2924. *Scymnus cervicalis* Muls. Gove county (Snow.)
——. *Scymnus punctatus* —. Lawrence.
——. *Pentilia* sp. Lawrence.
2994. *Stenelmis linearis* Zimm. Lawrence.
2996. *Stenelmis crenatus* Say. West Kansas.
2999. *Stenelmis vittipennis* Zimm. Lawrence.
3013. *Heterocerus collaris* Kies. Lawrence.
3042. *Hister marginicollis* Lec. Lawrence.
——. *Hister binotatus* —. Lawrence.
3062. *Hister bimarginatus* Linn. Lawrence.
3115. *Paromalus seminulum* Er.
3158. *Saprinus fimbriatus* Lec. Wallace county (Snow.)
——. *Acritus* sp. Lawrence.
3198. *Aeletes politus* Lec. Topeka.
3223. *Canthon ebenus* Say. Wallace county (Snow.)
3248. *Onthophagus orpheus* —. West Kansas and Lawrence.
3269. *Aphodius vittatus* Say. West Kansas and Lawrence.
3294. *Aphodius terminalis* Say. Lawrence.
3338. *Ochodæus musculus* Say. West Kansas.
3371. *Trox scutellaris* Say. Lawrence.
3385. *Trox erinaceus* Lec. Lawrence.
3451. *Diazus rudis* Lec.
3459*a*. *Diplotaxis frondicola* Bl. Lawrence.
3466. *Diplotaxis punctipennis* Lec. Lawrence.
3468. *Diplotaxis Harperi* Bl. West Kansas (Cooper.)
3475. *Diplotaxis morula* Lec. West Kansas.
3482. *Diplotaxis pacata* Lec. Kansas specimens were received from Prof. F. H. Snow.
3484. *Diplotaxis Haydeni* Lec. West Kansas (Cooper and Snow.)
3494. *Phyllophaga longitarsis* Say. West Kansas (Cooper.)
3511. *Phyllophaga lugubris* Lec. Topeka.
3519. *Phyllophaga prunina* Lec. Gove county (Snow.)
3521. *Phyllophaga affinis* Lec. Topeka.
3545. *Phyllophaga glabricula* Lec. Wallace county (Snow.)
3614. *Aphonus pyriformis* Lec. Wallace county (Snow.)
3615. *Aphonus tridentatus* Say. West Kansas.
3654. *Cremastochilus saucius* Lec. West Kansas (Cooper and Snow.)
3689. *Dicerca prolongata* Lec. Lawrence.
——. *Dicerca pruinosa*. Lawrence.
——. *Chrysobothrus* new species.
3739. *Anthaxia cyanella* Gory. Lawrence.

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3742. *Anthaxia quercata* Fab. Lawrence.
3827. *Agrilus pubiventris* Cr. Gove county (Snow.)
3828. *Agrilus egenus* Gory. Lawrence.
3829. *Agrilus lacustris* Lec.
3833. *Agrilus muticus* Lec. West Kansas.
——. *Agrilus subvittatus* Lec. Lawrence.
——. *Agrilus* new species near *torquatus* Lec.
——. *Agrilus* new species near *mancus*.
3836. *Taphrocerus gracilis* Say. West Kansas (Cooper); also at Lawrence.
3845. *Pachyscelus laevigatus* Say. Topeka; two specimens.
——. *Limonius interstitialis* —. Topeka.
3946. *Cardiophorus cardisce* Say. Lawrence.
4003. *Elater nigricollis* Hbst. Lawrence.
4009. *Elater Sayi* Lec. Lawrence.
4073. *Anchastus digitatus* Lec. Lawrence.
4154. *Melanotus verberans* Lec. Gove county (Snow.)
4159. *Melanotus paganus* Cand. Lawrence.
4171. *Melanotus sagittarius* Lec. Lawrence.
——. *Limonius interstitialis* —. Topeka.
4230. *Athous scapularis* Say. Lawrence.
4240. *Athous montanus* Lec. Lawrence.
——. *Asaphes brevicollis* —. Lawrence.
4347. *Asaphes bilobatus* Say. Lawrence.
4400. *Prionocyphon discoideus* Say. Topeka; rare.
4403. *Helodes pulchella* Guer. Topeka and Lawrence; rare.
4414. *Eucinetus terminalis* Lec. Topeka.
4448. *Lucidota punctata* Lec. Gove county (Snow.)
4453. *Photinus nigricans* Say.
4518. *Telephorus dentiger* Lec.
4527. *Telephorus dichrous* Lec.
4559. *Silis percomis* Say. Topeka.
4561. *Ditemnus bidentatus* Say. Wallace county (Snow.)
4563. *Loberus abdominalis* Lec. West Kansas.
——. *Loberus impressus* —. Lawrence.
4589. *Collops limbatus* Lec. West Kansas.
4612. *Anthocomus Erichsoni* Lec. Lawrence.
4628. *Attalus morulus* Lec. Lawrence.
4670. *Pristoscelis texanus* Lec. West Kansas.
4697. *Elasmocerus terminatus* Say. Lawrence.
4722. *Clerus Spinolæ* Lec. Gove county (Snow.)
4734. *Clerus cordifer* Lec. Wallace county (Snow.)
——. *Clerus* n. sp. Gove county (Snow.)
4765. *Hydnocera tabida* Lec. Gove county (Snow.)
4769. *Phyllobœnus dislocatus* Say. Lawrence.
4778. *Cregya oculata* Say. Lawrence.
4789. *Corynetes rufipes* Fab. West Kansas; common.
4822. *Oligomerus obtusus* Lec. Lawrence.
4824. *Sitodrepa panicea* L. Found in great numbers in some grains and seeds received in exchange at the Centennial Exhibition by the State Board of Agriculture.
——. *Sitodrepa* n sp.

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4839. *Petalium bistriatum* Say.
——. *Hemiptychus* new species.
4853. *Hemiptychus gravis* (?) Lec. Lawrence.
4863. *Cœnocara oculata* Say. Topeka and Lawrence; frequent on bushes and plants in the woods on Soldier creek.
4920. *Prionus fissicornis* Hald. Wallace county (Snow).
5001. *Elaphidion rufulum* Hald. Lawrence.
5015. *Elaphidion unicolor* Rand. Lawrence; bred from Red-bud (*Cercis Canadensis*) by Geo. C. Brackett, Esq.
5025. *Tylonotus bimaculatus* Hald. Lawrence.
5091. *Crossidus pulchellus* Lec. West Kansas.
5094. *Crossidius discoideus* Say. West Kansas.
5104. *Cyllene decora* Oliv. var *infausta* Lec. Gove county (Snow).
5291. *Leptura sphæricollis* Say. Lawrence.
5310. *Monilema semipunctatum* Lec. West Kansas; common on *Opuntia*. (Cooper.)
5311. *Monilema armatum* Lec. West Kansas.
—— *Sternidius* new species. Lawrence.
5394. *Eupogonius vestitus* Say. Lawrence.
5427. *Oberea ruficollis* Fab. West Kansas.
5433*a*. *Oberea basalis* Lec. Gove county (Snow.)
5439. *Oberea Schaumii* Lec. var. Lawrence.
——. *Tetrops* sp. Lawrence.
5460. *Caryoborus arthriticus* Fab. Lawrence.
5465. *Bruchus scutellaris* Fab. Lawrence.
5478. *Bruchus limbatus* Horn.
5481. *Bruchus pruininus* Horn. Gove county, from S. W. Williston.
5496. *Bruchus fraterculus* Horn. Topeka, and Wallace county.
——. *Bruchus* n. sp. Lawrence.
5514. *Donacia alutacea* Lec. Lawrence.
5534. *Orsodachna atra* Ahr. Topeka and Lawrence; very common in spring in certain localities on the blossoms of wild plum. Var. *vittata* occurs at Lawrence.
5578. *Exema conspersa* Mann. Lawrence.
5578*a*. *Exema dispar* Lec. Topeka; frequent.
5587. *Cryptocephalus sellatus* Suffr. Lawrence.
5588. *Cryptocephalus lituratus* Fab.
5588*a*. *Cryptocephalus lativittis* Germ. Topeka.
5589. *Cryptocephalus venustus* Fab. Topeka and Lawrence.
5595. *Cryptocephalus confluens* Say. West Kansas.
5609. *Cryptocephalus notatus* Fab. Lawrence.
5613. *Cryptocephalus catarius* Suffr. Common on plants in woods in spring; Topeka.
5617. *Cryptocephalus chlorizans* Suffr. Lawrence.
——. *Cryptocephalus* new species. With 5613, and very common.
5664. *Pachybrachys hepaticus* Mels. Topeka and West Kansas.
5666. *Fidia murina* Cr. Lawrence.
——. *Heteraspis* new species. Topeka; two specimens.
5674. *Heteraspis smaragdula* Lec. West Kansas (Cooper.)
5693. *Chalcoparia globosa* Oliv. West Kansas (Cooper and Snow).
5695. *Paria aterrima* Oliv., var. *canella*. Lawrence.
——. *Chalcophana picipes* Oliv. West Kansas (Cooper).

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5715*a*. *Colaspis flavida* Say, var. *lineata*. Gove county (Snow).
5730. *Chrysomela conjuncta* Rog. Wallace county (Snow).
5733. *Chrysomela disrupta* Rog. Lawrence, and Gove county.
5750. *Chrysomela auripennis* Say. Lawrence.
5772. *Plagiodera oviformis* Lec. Gove county (Snow).
——. *Adimonia externa* Say. Lawrence.
5756. *Gastrophysa formosa* Say. West Kansas.
5805. *Diabrotica blandula* Lec. West Kansas (Snow).
——. *Diabrotica* new species. West Kansas.
5822. *Galerucella sagittariae* Gyll. Topeka; rare.
5826. *Galerucella notata* Fab. West Kansas.
5838. *Trirhabda nitidicollis* Lec. Wallace county (Snow).
5842. *Hypolampsis pilosa* Ill. Lawrence.
5861. *Oedionychis sexmaculata* Ill. Topeka; one specimen; also taken at Lawrence.
5871. *Disonycha discoidea* Fab. Lawrence.
5874. *Disonycha collaris* F. race *mellicollis* Say. Lawrence.
5875. *Graptodera* var. *subplicata* Lec. Topeka; very common on willows along the Kansas river.
5878. *Graptodera ignita* Ill. (var.) Topeka and Lawrence.
5881. *Graptodera obliterata* Lec. Topeka and Lawrence.
5882. *Graptodera torquata* Lec. West Kansas (Cooper and Williston).
——. *Graptodera bimarginata* Say.
——. *Graptodera* new species.
5900. *Batophila cerina* (?) Lec. Lawrence.
5906. *Orchestris bipustulata* Fab. Topeka and Lawrence; frequent.
5908. *Orchestris Lewisii* Cr.
5924. *Lyperaltica fuscula* Lec. Topeka, on composite flowers; common.
5925. *Lyperaltica senilis* Say. Topeka; four specimens taken on *Actinomeris*.
5927. *Crepidodera erythropus* Mels.
5928. *Crepidodera* var. *violacea* Mels. Common in spring on leaves of wild cherry (Prunus).
5928. *Crepidodera* var. *opulenta* Lec. Common on leaves of willow.
5930*a*. *Crepidodera mancula* Lec. Lawrence.
5931. *Crepidodera scabricula* Cr. Topeka; one specimen.
——. *Crepidodera* new species. Lawrence.
5935. *Epitrix fuscula* Cr. Topeka; common in timber on various plants.
5937. *Epitrix* near *hirtipennis* Mels. Lawrence.
5941. *Chætocnema subviridis* Lec. Topeka and Lawrence.
5947. *Chætocnema confinis* Cr. Lawrence.
5971. *Microrhopala porcata* Mels. West Kansas.
5977. *Chelymorpha Lewisii* Cr. West Kansas.
5980*b*. *Cassida ellipsis* Lec. West Kansas (Snow).
——. *Cassida sexpunctata* —. West Kansas; frequent on *Ipomœa leptophylla*.
6168. *Eleodes fusiformis* Lec. West Kansas (Cooper).
6245. *Blapstinus vestitus* Lec. Wallace county (Snow).
6291. *Paratenetus punctatus* Sol. Topeka and Lawrence.
——. *Paratenetus* new species. Topeka.
——. *Mycetochares lugubris* —. Lawrence.
6390. *Isomera quadristriata* Cooper. Topeka.
6456. *Notoxus apicalis* Lec. West Kansas.

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6458. *Notoxus subtilis* Lec. Wallace county (Snow).
6459. *Notoxus bifasciatus* Lec. Topeka.
——. *Notoxus* n. sp. Lawrence.
6472. *Anthicus elegans* Laf. Lawrence.
6479. *Anthicus floralis* Payk. Topeka; frequent.
6501. *Anthicus spretus* Lec. Lawrence.
——. *Anthicus* n. sp. Lawrence.
6527. *Xylophilus fasciatus* Mels. Lawrence.
6541. *Synchroa punctata* Newm. Lawrence.
6560. *Symphora flavicollis* Hald. Topeka; rare.
6561. *Symphora rugosa* Hald. Lawrence.
6583. *Anaspis rufa* Say. Gove county (Snow).
6606. *Mordella discoidea* Mels. Lawrence.
6628. *Mordellistena amica* Lec. Lawrence.
6648. *Mordellistena unicolor* Lec. Wallace county and Gove county (Snow.)
6662. *Mordellistena suturella* Helmuth. Gove county (Snow.)
——. *Mordellistena* new species. Wallace county (Snow.)
——. *Epicauta trichrus* var. Gove county (Snow.)
6742. *Epicauta Stuarti* Lec. Wallace county (Snow.)
6740. *Epicauta lemniscata* Fab. Lawrence.
6809. *Nemognatha lurida* Lec. Wallace county and Gove county (Snow.)
Gnathium new species. West Kansas.
Eugnamptus angustatus Hbst. Lawrence.
Rhynchites cyanellus Lec. Lawrence.
Rhynchites aeratus Say. Lawrence.
Rhynchites hirtus Oliv. West Kansas.
Attelabus nigripes Lec. Lawrence.
Epicærus formidolosus Schh. Lawrence.
Eupagoderes sordidus Lec. Lawrence.
Sitones tibialis Germ. Gove county (Snow.)
Listronotus squamiger Say. Lawrence.
Listronotus caudatus Say. This species and *L. nebulosus* occur together on *Sagittaria.*
Lixus scrobicollis Schh. Lawrence.
Dorytomus brevicollis Lec. Topeka; common on willow.
Dorytomus squamosus Lec. Topeka, and Gove county.
Smicronyx tychoides Lec. Lawrence.
Smicronyx vestitus Lec. Topeka.
Smicronyx squamulatus Lec. Topeka.
Smicronyx new species. Topeka and Lawrence.
Endalus limatulus Lap. Gove county (Snow.)
Lissorhoptrus apiculatus Gyll. Lawrence.
Otidocephalus myrmex Hbst. Lawrence.
Otidocephalus Chevrolatii Horn. Topeka; three specimens.
Magdalis pandura Say. Topeka and Lawrence.
Anthonomus fulvus Lec. West Kansas.
Anthonomus rubidus Lec. Topeka.
Anthonomus squamosus Lec. West Kansas.
Anthonomus corvulus Lec. Lawrence.
Anthonomus sycophanta Walsh. Topeka.
Orchestes ephippiatus Say. Topeka and Lawrence; frequent on willow.

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Alyca ephippiata Say. Topeka and Lawrence; frequent on willows.
Thysanocnemis fraxini Lec. Lawrence.
Conotrachelus cribricollis Say.
Conotrachelus cratægi Walsh. Lawrence.
Conotrachelus new species. Topeka; one specimen.
Rhyssematus palmacollis Say. Lawrence.
Rhyssematus æqualis —.
Acalles turbidus Lec. West Kansas (Snow.)
Acalles carinatus Lec. Lawrence.
Cryptorhynchus obliquefasciatus Boh. Lawrence.
Acamptus rigidus Lec. Lawrence.
Ceutorhynchus decipiens Lec. Gove county (Snow.)
Ceutorhynchus new species. West Kansas.
Pelenomus sulcicollis Fahr. Lawrence.
Baris macer (?) Lec. Gove county (Snow.)
Baris confinis Lec. Topeka and Lawrence.
Baris transversa Lec. West Kansas.
Baris tumescens Lec. Lawrence.
Baris striata Say.
Baris new species, near *carinulata*.
Baris pruinosa Lec. West Kansas and Lawrence.
Ampeloglypter Sesostris Lec. Lawrence. Injures grape vines.
Microcholus new species. Topeka; two specimens.
Barilepton cribricolle Lec. Lawrence.
Barilepton quadricolle —. West Kansas.
Centrinus neglectus Lec. Lawrence.
Centrinus falsus Lec.
Centrinus prolixus —. West Kansas.
Centrinus confusus Boh.
Centrinus modestus Boh.
Sphenophorus ochreus Lec. Lawrence.
Sphenophorus æqualis Gyll.
Sphenophorus melanocephalus Fab.
Sphenophorus pertinax Oliv. Topeka and Lawrence.
Sphenophorus vomerinus Lec., var. *baridioides*. West Kansas (Snow.)
Sphenophorus placidus Say. Lawrence.
Hypothenemus hispidulus Lec. Topeka.
Hypothenemus distinctus Lec. Lawrence.
Micracis suturalis Lec. Lawrence.
Scolytus quadrispinosus Say. Lawrence.
Hylesinus aculeatus Say. Lawrence.
Eurymycter fasciatus Oliv. Lawrence.
Hormiscus saltator Lec. Topeka and Lawrence.
Anthribus cornutus Say. Lawrence.

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A NEW METHOD OF DETERMINING THE WIND'S VELOCITY.

By JOHN H. LONG, Class of '77, University of Kansas.

It having been repeatedly stated by certain observers in Kansas that the anemometer of the State University registered a higher than probable velocity, I was induced at the suggestion of two gentlemen connected with the institution, to test the correctness of the instrument. The apparatus used by me was very simple, consisting essentially of a hollow copper sphere suspended in front of a graduated horizontal scale. But as a more detailed description may be necessary to the understanding of what follows, I will give it here. Imagine first a perpendicular shaft of iron, eighteen feet long, whose bottom fits into a socket and to whose top is attached a swivel. To this swivel are fastened several wires whose other extremities are secured so as to give complete steadiness to the shaft. Other braces are attached for the same purpose, and the swivel on top permits it to turn to suit the varying direction of the wind. A short distance below the swivel a horizontal arm, fifteen inches in length, is firmly attached to the shaft, and just below this another one is similarly attached. These two arms are equal in length and parallel to each other. To the extremity of the upper arm are fastened two fine iron wires, one, seventeen feet long, supporting a plummet, and the other, six and a half feet long, supporting the copper sphere mentioned above. This sphere is 8.5 centimetres in diameter, and weighs 135.92 grammes. To the extremity of the lower arm is attached the scale, consisting of two lath-like pieces of wood, about four feet long, fastened parallel to each other and about one-half inch apart. Between these, constituting a guide, the wires are suspended, and on the front one the graduation is made. The plumb line serves to determine the zero point, and is of no further use. By means of the swivel above and the socket below, the apparatus is easily turned, so that when the ball is deflected by the wind its vibrations may take place in the space between the two laths. The observation consists in registering the amount of this deflection from the zero point, or point in which the perpendicular line cuts the scale. It is well known that the force of the wind is not constant for any great length of time. It is hence necessary to take a great many observations, at short intervals, in order to obtain a correct mean. In my work I noticed the deflection of the ball through fifteen minutes, making a record every fifteen seconds, which gave me sixty observations for the quarter of an hour. The following table taken from my note book will illustrate:

June 19,	40	m.	past	6,	def.=	20	centimetres.	June 19,	41	m. past 6, def.=	16 centimetres.
	40¼	"		6,	"	18	"		41¼	" 6, "	18 "
	40½	"		6,	"	20	"		41½	" 6, "	19 "
	40¾	"		6,	"	17	"	etc.			

Cup anemometer marked 15.24 m. per hour.

I observed always the record of the anemometer for the same fifteen minutes, and at the close of my work, which was continued on several days to obtain mean deflections corresponding to different velocities, I had a number of such records as the above, each consisting of the position of the ball at sixty different periods.

By a well known principle of mechanics I found the force or *pressure* of the wind

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necessary to produce in the ball of known weight the observed deflections, and for convenience made the following table :

For deflection of	1	centimetre,	force	=	.73	gramme.
" " "	2	"	"		1.46	grammes.
" " "	3	"	"		2.19	"
" " "	4	"	"		2.92	"
* *	*	*	*		*	*
" " "	60	"	"		43.80	"

Having this table of pressures, the next question is to find the wind's velocity corresponding to each of them. There are several empirical formulas, which might be applied to the solution of a problem such as this, but one proposed by Weisbach seems to be the most reliable. It is for the action of an unlimited stream, either of water or air, and by giving suitable values to some of its factors it affords an easy solution to the problem in hand. I do not know that it has ever before been applied in this way, but I find the results obtained agree very closely with those derived from a formula computed by Colonel James for the British Board of Trade. The formula is this :

$$P = z \frac{v^2}{2g} Fy,$$

in which P is the pressure of the wind, z a term dependent on the shape of the body exposed to the wind, $\frac{v^2}{2g}$ the height due to the velocity v, F the exposed area, y the density of the air. The value of z has been found from experiment to be about 0.64, so transposing the equation to find the value of v^2 we have,

$$v^2 = \frac{2g\,P}{.64\,Fy},$$

from which the numerical value of v can be easily found, as those of g, P, F and z are known. It must be observed that the value of z varies with the barometric height, making it necessary to read the barometer for each set of observations. It is now easy to construct another table, as follows :

For deflection of	1	cen.,	velocity	= 3.9	m.	per h.
" "	2	"	"	5.51	"	"
" "	3	"	"	6.74	"	"
" "	4	"	"	7.80	"	"
* *	*	*	*	*	*	*
" "	60	"	"	30.2	"	"

Finally these values are substituted in the columns of deflections observed, and a mean obtained which represents the wind's velocity for the fifteen minutes of observation.

After making a large number of experiments as above described, I learned these facts regarding the anemometer at the Kansas University: First, that it never registers too much; and second, that for small velocities it does not register enough. This is due to the fact that a gentle wind, whose strength, however, is sufficient to deflect the ball, will fail to move the cups sometimes for many minutes.

The following figures will show results obtained by both methods. The first column contains the velocities determined by the deflected ball, and the second those determined for the same time by the anemometer.

5.6 m. per h.	.64 m. per h.	15.3 m. per h.	15. m. per h.
10.5 " "	4.84 " "	15.6 " "	14.88 " "
11.68 " "	10.62 " "	17 5 " "	16. " "
13.5 " "	10.89 " "	18.2 " "	18.15 " "
13.7 " "	12.81 " "	18.7 " "	18.39 " "
14.7 " "	14.5 " "	20. " "	19 2 " "
15. " "	14.5 " "	25.3 " "	25.14 " "

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It will be observed that for medium and high velocities the two methods compared very well, and for low velocities, as intimated, the anemometer fails to give a large enough record. Besides showing that the apparatus at Lawrence can not register too much, my observations have convinced me that the method is one which may be of value to meteorologists. From its extreme simplicity and lightness, the instrument may be easily carried from place to place by traveling observers, and a record of the wind's velocity at any station can be obtained in a few minutes. As a check upon another instrument it may be used to advantage as just shown. The dimensions which I have given are larger than necessary. I chose them in order to have the copper ball on a level with the cups of the anemometer.

METEOROLOGICAL SUMMARY FOR 1877.

Prof. F. H. SNOW's Annual Report as Meteorologist to the State Board of Agriculture.

Station: Lawrence, Kansas. Latitude, 38° 57′ 25″; longitude, 95° 15′; elevation of barometer and thermometers, 875 feet above the sea level, and five feet above the ground; rain gauge on the ground; anemometer, 105 feet above the ground, on the dome of the University building, 1,200 feet above the sea level.

The chief characteristics of the weather of 1877 were the large and well-distributed rainfall, the low temperature of the summer months, the high temperature of the winter months, the unusual degree of atmospheric humidity, and the comparative lightness of the winds.

TEMPERATURE.

Mean temperature of the year, 54°.16, which is 1°.33 above the mean of the nine preceding years. The highest temperature was 99°, on the 7th of July; the lowest was 9° below zero, on the 16th of January, giving a yearly range of 108°. Mean temperature at 7 A. M., 48°.54; at 2 P. M., 62°.50; at 9 P. M., 52°.81.

Mean temperature of the winter months, 36°.56, which is 7°.71 above the average winter temperature; of the spring, 52°.81, which is 0°.02 above the average; of the summer, 73°.75, which is 2°.86 below the average; of the autumn, 53°.54, which is 1°.20 above the average.

The coldest month of the year was January, with a mean temperature of 25°.60; the coldest week was January 7th to 13th, with mean temperature, 17°.49; the coldest day was January 12th, with mean temperature, 3°.2. The mercury fell below zero but three times, all of which were in January.

The warmest month of the year was July, with a mean temperature of 75°.13; the warmest week was July 2d to 8th, with mean temperature 82°.64; the warmest day was July 7th, with mean temperature, 86°. The mercury reached or exceeded 90° on only twenty days, viz: four in June, eight in July, seven in August, and one in September.

The last light frost of spring was on May 1st; the first light frost of autumn was on October 4th, giving an interval of 156 days entirely without frost. The last severe frost of spring was on April 2d; the first severe frost of autumn was on November 5th, giving an interval of fully seven months, or 217 days, without severe

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frost. No frost or cold weather during the year caused any damage to fruit or fruit buds.

RAIN.

The entire amount of rain, including melted snow, was 41.09 inches, which is 6.71 inches above the average annual amount for the nine preceding years. Either rain or snow fell on 126 days, which is the largest number of rainy days in any year of our record. The longest interval without rain during the growing season (March 1st to September 15th), was ten days, July 27th to August 6th. The number of thunder showers was thirty-nine, of which two occurred in December.

SNOW.

The entire depth of snow was 15½ inches, of which 8 inches fell in January, 2 inches in February, 5 inches in March, and half an inch in December. The last snow of spring was on April 3d; the first snow of autumn was on November 8th.

FACE OF THE SKY.

The average cloudiness of the year was 47.12 per cent., which is 2.16 per cent. above the average. The number of clear days (less than one-third cloudy) was 162; half-clear days (from one-third to two-thirds cloudy), 92; cloudy (more than two-thirds), 111. There were 51 entirely clear and 50 entirely cloudy days. The clearest month was August, with an average cloudiness of 29.57 per cent.; the cloudiest month was May, with an average of 62.93 per cent. The mean cloudiness at 7 A. M. was 51.14 per cent.; at 2 P. M., 50.74 per cent.; at 9 P. M., 39.48 per cent.

DIRECTION OF WIND.

During the year, three observations daily, the wind was from the N. W. 278 times; S.W., 259 times; S. E., 184 times; N. E., 148 times; S., 80 times; N., 59 times; E., 38 times; W., 18 times; calm, 31 times. The south winds (including southwest, south and southeast), outnumbered the north winds (including northwest, north and northeast), in the ratio of 523 to 485.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 113,967, which is 33,485 miles less than the average annual distance for the past five years. This gives a mean daily velocity of 312.24 miles, and an average hourly velocity of 13.01 miles. The highest hourly velocity was 55 miles, on March 16th and November 5th; the highest daily velocity was 969 miles on March 8th; the highest monthly velocity was 13,981 miles, in March. The three windiest months were March, April and May; the three calmest months were August, September and October. The average hourly velocity of the wind at 7 A. M. was 11.66 miles; at 2 P. M., 15.55 miles; at 9 P. M., 12.54 miles.

BAROMETER.

Mean height of the barometer, 29.117 inches; mean at 7 A. M., 29.140 inches; at 2 P. M., 29.093 inches; at 9 P. M., 29.120 inches. Maximum, 29.751 inches, on January 22d; minimum, 28.364 inches, on April 18th; yearly range, 1.387 inches. The highest monthly mean was 29.301 inches, in February; the lowest was 28.995 inches, in April. The barometer observations are corrected for temperature and instrumental error.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 72.6; at 7 A. M., 82.12; at 2 P. M., 56.76; at 9 P. M., 79.09. The dampest month was October, with mean humidity,

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79.36; the driest month was April, with mean humidity, 64.90. There were eleven fogs during the year. The lowest humidity for any single observation was 22.5, on April 5th.

The following tables give the mean temperature, the extremes of temperature, the velocity of the wind, the percentage of cloudiness, the relative humidity, and the rainfall for each month of the year 1877, and a comparison with preceding years:

YEAR 1877.

MONTHS.	MEAN TEMPERATURE.	MAXIMUM TEMPERATURE.	MINIMUM TEMPERATURE.	MILES OF WIND.	CLOUDINESS.	RELATIVE HUMIDITY.	RAINFALL IN INCHES.
January	25°.60	62.5	—9.0	9,178	43.8	75.5	1.17
February	39.65	66.0	21.0	7,718	47.1	71.8	0.89
March	40.03	81.0	7.0	13,961	54.1	67.2	3.49
April	53.90	81.0	25.0	11,976	53.0	64.9	3.13
May	64.50	85.0	37.0	11,522	62.9	72.0	6.45
June	72.03	95.0	47.0	8,741	38.7	75.3	7.30
July	75.13	99.0	54.0	8,355	32.0	73.4	5.76
August	74.10	97.0	51.5	7,972	29.5	72.0	2.30
September	66.93	90.0	43.0	6,817	33.5	71.7	1.35
October	54.45	80.0	34.0	7,530	58.5	79.4	5.85
November	39.23	64.0	9.0	9,494	43.9	73.8	1.47
December	44.43	68.0	10.0	10,683	58.1	74.4	2.21

COMPARISON WITH PREVIOUS YEARS.

YEARS.	MEAN TEMPERATURE.	MAXIMUM TEMPERATURE.	MINIMUM TEMPERATURE.	MILES OF WIND.	CLOUDINESS.	RELATIVE HUMIDITY.	RAINFALL IN INCHES.
1877	54°.16	99.0	—9.0	113,967	47.13	72.6	41.09
1876	53.76	98.0	—5.0	148,130	41.27	66.8	44.18
1875	50.60	99.0	—16.5	145,316	44.81	65.5	38.87
1874	54.20	108.0	—3.0	145,865	45.54	65.5	38.87
1873	52.71	104.0	—26.0	154,508	43.46	64.0	33.94
1872	51.90	97.0	—18.0	.....	44.33	64.4	33.66
1871	54.20	108.0	—6.0	.....	47.37	.....	33.28
1870	54.50	102.0	—10.0	.....	47.88	68.4	31.38
1869	50.99	96.0	—5.0	.....	49.23	.....	39.51
1868	53.36	101.0	—16.5	.....	42.35	.....	37.42

In presenting the above report, I desire to acknowledge my indebtedness to Prof. F. O. Marvin for taking the observations during my six weeks' absence in the summer vacation.

F. H. S.

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INDEX.

A

PAGE

Adams, F. G.—
Kansas Mounds 51
Additions to the List of Kansas Birds, by F. H. Snow 38
Additions to the List of Kansas Plants, by J. H. Carruth 40
Additions to the Catalogue of Kansas Coleoptera, by E. A. Popenoe 77
Adult Male Plumage of Wilson's Phalarope, by S. W. Williston 39
Amblychila Cylindriformis Say, by F. H. Snow 29
American Jurassic Dinosaurs, by S. W. Williston 42
Antiquity of Man, Notes on, by A. H. Thompson 12

B

Bardwell, Prof. F. W., resolutions of respect to the memory of 5
Bite of the Rattlesnake, by J. Savage 36
Botanical Addenda, by J. H. Carruth 40

C

Carruth, J. H.—
Botanical Addenda 40
Cicindelæ, notes on habits, by S. W. Williston 32
Coleoptera of Kansas, Additions to List, by E. A. Popenoe 77
Coleoptera of Wallace County, Kansas, by F. H. Snow 62
Coleoptera of Platte Canon, Colorado, by F. H. Snow 75
Cretaceous Forests and their Migrations, by B. F. Mudge 46

D

Dermal Covering of a Mosasauroid Reptile, by F. H. Snow 54

F

PAGE

Fishes of the Marais des Cygnes, list, by Wm. Wheeler 33
Fossil Tusk, found in Franklin County, by Wm. Wheeler 11
Frazer, Gen. John, resolutions of respect to the memory of 5

G

Giant's Causeway and Fingal's Cave, by C. D. Merrill 6

H

Habits of some rarer *Cicindelæ*, by S. W. Williston 32
Habits of Richardson's Spermophile, by S. W. Williston 39

I

Insects of Wallace County, Kansas, by F. H. Snow 61
Internal Heat of the Earth, by B. F. Mudge ... 49
Iola (Kansas) Mineral Well, by W. K. Kedzie. 58

K

Kansas Mounds, by F. G. Adams 51
Kedzie, Prof. Wm. K.—
Iola Mineral Well 58
Ozone in Kansas Atmosphere 18

L

Liodon dyspelor Cope, dermal covering, by F. H. Snow 54
Library and Museum, report on 5
List of Lepidoptera collected in Colorado, by F. H Snow 70

Digitized by Google

PAGE

List of Kansas Snakes in University Museum, by A. E. Mozley.... 34
List of Officers and Commissions for 1878-9... 5
Long, J. H.—
Method of determining the Velocity of the Wind..... 87
Lovewell, Prof. J. T.—
Sound Transmission by Electricity..... 25

M

Mastodon Remains in Douglas County, by J. Savage.. 10
Merrill, Prof. C. D.—
Notes on Giant's Causeway and Fingal's Cave..... 6
Meteorological Summary for 1877, by F. H. Snow..... 89
Method of determining the Velocity of the Wind, by J. H. Long..... 87
Mozley, Miss A. E.—
List of Kansas Snakes in Museum of State University 34
Mudge, Prof. B. F.—
Cretaceous Forests and their Migrations.. 46
Internal Heat of the Earth..... 49

N

Notes on the Antiquity of Man, by A. H. Thompson 12
Notes on Giant's Causeway and Fingal's Cave, by C. D. Merrill 6
Notes on the Habits of some rarer *Cicindelæ*, by S. W. Williston..... 32

O

Ozone in Kansas Atmosphere, by W. K. Kedzie 18

P

PAGE

Popenoe, E. A.—
Additions to List of Kansas Coleoptera... 77

S

Savage, J.—
Mastodon Remains in Douglas County.... 10
On the Bite of the Rattlesnake..... 36
Secretary, Report of..... 3
Snow, Prof. F. H.—
Additions to Catalogue of Kansas Birds.. 38
Amblychila Cylindriformis Say..... 29
Coleoptera of Platte Canon, Colorado..... 75
Insects of Wallace County, Kansas 61
Lepidoptera collected in Colorado..... 70
Meteorological Summary for 1877 89
On the Dermal Covering of a Mosasauroid Reptile..... 54
Sound Transmission by Electricity, by J. T. Lovewell..... 25
Spermophilus Richardsonii, by S. W. Williston..... 39
Steganopus Wilsoni, adult male plumage, by S. W. Williston 39

T

Thompson, Dr. A. H.—
Notes on the Antiquity of Man 12

W

Wheeler, Prof. Wm.—
Fishes of the Marais des Cygnes..... 33
On a Fossil Tusk, found in Franklin County..... 11
Williston, S. W.—
American Jurassic Dinosaurs..... 42
Notes on the Habits of some of the rarer *Cicindelæ*..... 32
On the Adult Male Plumage of Wilson's Phalarope..... 39
Spermophilus Richardsonii..... 39

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2044 106 308 166

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